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EIGHTH ANNUAL REPORT

OF THE

BOARD OF CONTROL

OF THE

STATE AGRICULTURAL EXPERIMENT STATION

AT

AMHERST, MASS.

1890.

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MASSACHUSETTS STATE

AGRICULTURAL EXPERIMENT STATION,

AMHERST, MASS.

BOARD OF CONTROL, 1890.

His Excellency J. Q. A. Brackett,
Governor of the Commonwealth, President ex officio.

P. M. Harwood of Barre, ... Term expires, 1892.
W. W. Rawson of Arlington, ... Term expires, 1891.
Appointed by the State Board of Agriculture.

J. H. Demond of Northampton, . . . Term expires, 1892.
T. P. Root of Barre, ... Term expires, 1891.
Appointed by the Board of Trustees of the Massachusetts Agricultural College.

F. H. Appleton of Peabody, ... Term expires, 1891.
Appointed by the Massachusetts Society for Promoting Agriculture.

Elbridge Cushman of Lakeville, . . . Term expires, 1892.
Appointed by the Massachusetts State Grange.

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Appointed by the Massachusetts Horticultural Society.

H. H. Goodell, A.M., Amherst,
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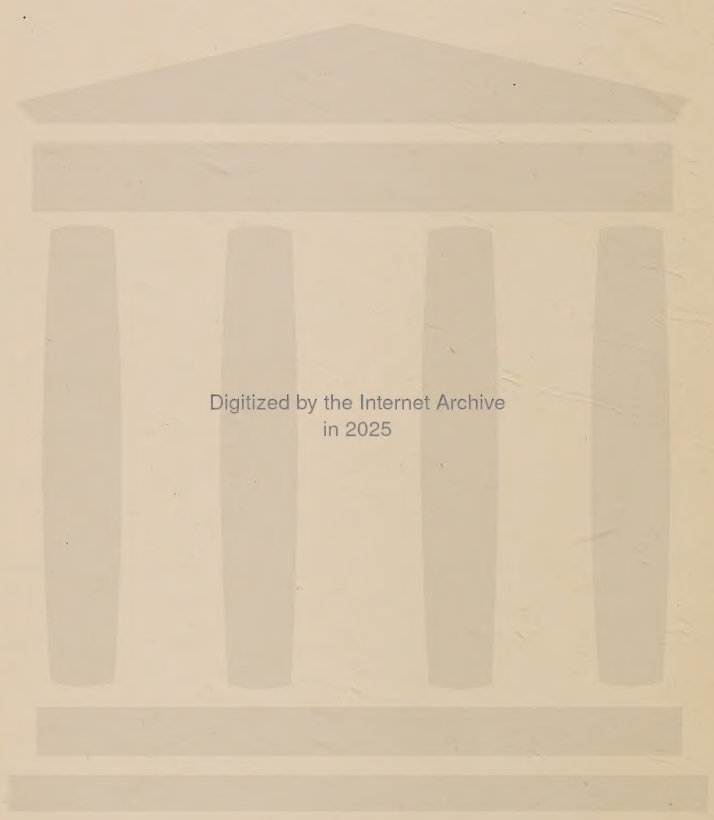
C. A. Goessmann, Ph.D., LL.D., Amherst,
Director of the Station.

Wm. R. Sessions, Hampden,
Secretary of the State Board of Agriculture.

Wm. R. Sessions, Hampden,
Secretary and Auditor.

Frank E. Paige, Amherst,
Treasurer.



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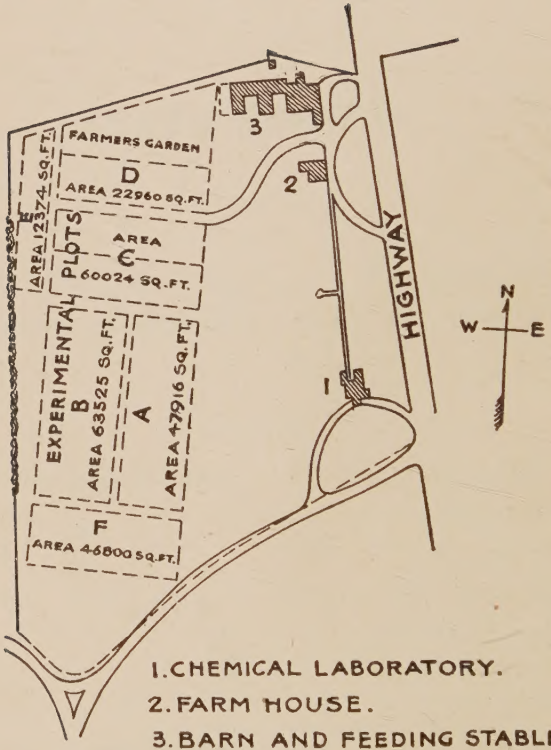
STATION STAFF.

C. A. GOESSMANN, Ph.D., LL.D., *Director and Chemist*, . Amherst.
J. E. HUMPHREY, S.B., *Vegetable Physiologist (Mycologist)*, Amherst.

ASSISTANTS.

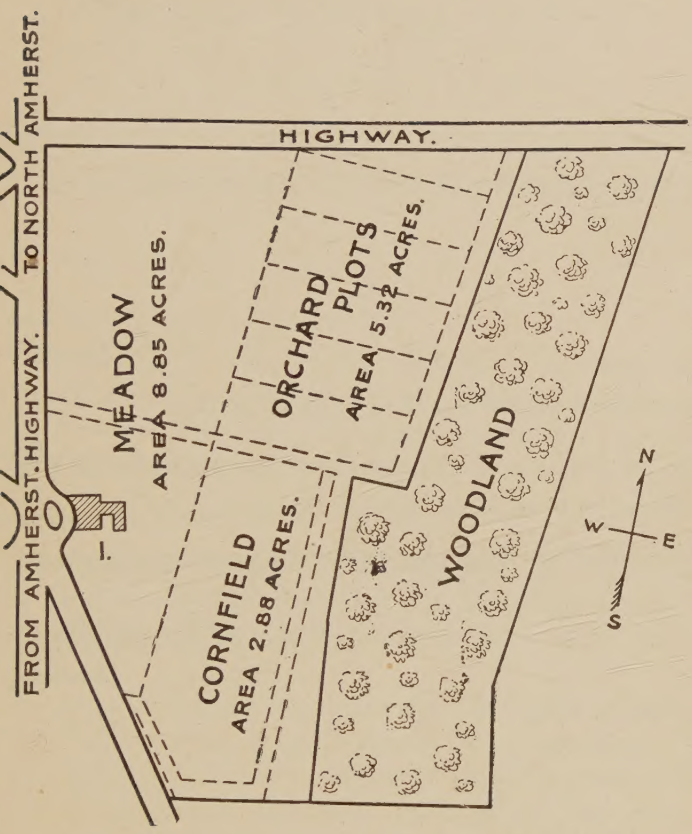
W. H. BEAL, A B., M.E , . .	*General and Analytical Chemistry.*
E. R. FLINT, B S.,*	" " " "
R. B. MOORE, B.S., ...	" " " "
C. S. CROCKER, B.S., . .	" " " "
B. L. HARTWELL, B.S., . .	" " " "
H. D. HASKINS, B S., . .	" " " "
C. H. JONES, B.S., ...	" " " "
W. A. PARSONS, B S., . .	*Field Experiments and Stock Feeding.*
DAVID WENTZELL, . . .	*Farmer.*

* Resigned July 1, 1890.



1. CHEMICAL LABORATORY.
2. FARM HOUSE.
3. BARN AND FEEDING STABLES.

MAP OF LAND LEASED TO THE
MASSACHUSETTS EXPERIMENT STATION
FROM THE
AGRICULTURAL COLLEGE FARM
WEST OF THE HIGHWAY
AREA TAKEN 17.72 ACRES



1. AGRICULTURAL & PHYSIOLOGICAL LABORATORY.

MAP · OF · LAND · LEASED · TO · THE

MASSACHUSETTS · EXPERIMENT · STATION

· FROM · THE ·

AGRICULTURAL · COLLEGE · FARM

EAST · OF · THE · HIGHWAY

AREA · TAKEN · 30.52 · ACRES

Boston, Jan. 9, 1891.

To the Honorable Senate and House of Representatives.

In accordance with chapter 212 of the Acts of 1882 I have the honor to present the Eighth Annual Report of the Board of Control of the State Agricultural Experiment Station.

WM. R. SESSIONS,
Secretary.

EIGHTH ANNUAL REPORT

OF THE

DIRECTOR OF THE MASSACHUSETTS STATE AGRICULTURAL EXPERIMENT STATION AT AMHERST, MASS.

To the Honorable Board of Control.

GENTLEMEN : — The present condition of the State Agricultural Experiment Station may be considered a satisfactory one, as far as buildings and general outfit are concerned. The older buildings are in a good state of repair, and the new ones are well equipped for the purpose they are to serve.

The experimental work of the past year has been extensive, and in various directions. A favorable season has materially assisted in a successful termination of the work in the field.

No material changes have been made in regard to different lines of observation, decided upon at the beginning of the year. The details of the management have been carried out, as far as practicable, according to the plans from time to time presented for your consideration. Investigations in the laboratory, the vegetation house, the field and the barn, have received their due share of attention.

Professor Humphrey has continued his study of fungoidal diseases of plants, in various directions. A detailed description of his work in that connection forms a chapter in the annual report.

A series of field experiments, inaugurated at the close of the past season (1890), for the purpose of studying the effect of different forms of nitrogen and of phosphoric acid on the growth of winter rye and winter wheat, has been supplemented by control observations in pots in the vegetation house.

A number of reputed fodder crops, more or less new to the soil of Massachusetts, have been studied with regard to their adaptation to our climate and soil. Some of these have been raised in sufficient quantity to test their services as green fodder or hay for milk production.

Feeding experiments with milch cows with reference to an economical production of milk, and with young pigs for a remunerative production of pork, have been continued.

Considerable attention has been paid to the cost of the feed for the production of mutton and beef.

The work in the chemical laboratory has been, as usual, quite large, and for different purposes. The chemical analyses made at the station laboratory during the entire year, aside from four hundred analyses for the Hatch Station of the Agricultural College, number some nine hundred. Of these, from three hundred to four hundred were made at the special request of farmers in the State. They include analyses of fertilizers, fodder articles, well water, milk, etc.

The details of the work carried on in the directions previously stated are recorded in the subsequent pages of the annual report for 1890, under the following headings: —

Feeding Experiments.

I. Two feeding experiments with milch cows.
   1. Some general remarks on our previous feeding experiments with milch cows.
   2. Feeding experiment with milch cows, to compare the value of old-process linseed meal with that of new-process linseed meal.
   3. Feeding experiment with milch cows, to compare the economical value of reputed fodder crops, — vetch and oats, and soja bean, — when fed as green fodder in part or in whole for English hay.
   4. Creamery record for 1889 and 1890.

II. Feeding experiments with lambs, to ascertain the cost of feed when fattening lambs, by means of winter fodder rations, for the meat market.

III. Feeding experiments with pigs, — skim-milk, corn meal, corn and cob meal, wheat bran and gluten meal, serving as fodder ingredients of the daily diet.

IV. Fodder analyses, 1890.

Field Experiments.

V. Some suggestions regarding the question, How can we improve in an economical way the productiveness of our farm lands?

VI. Experiments to ascertain the effect of different combinations of nitrogen on oats.

VII. Field experiments with prominent grasses and leguminous plants, to study their composition and general economical value.

VIII. Field experiments with reputed field and garden crops, to ascertain their adaptation to our soil and climate.

IX. Field experiments to study the economy of using different commercial sources of phosphoric acid for manurial purposes in farm practice, — potatoes.

X. Experiments with grass land.

XI. Report on general farm work.

XII. Professor Humphrey's report.

Special Work in the Chemical Laboratory.

XIII. Analyses of licensed commercial fertilizers.

XIV. Miscellaneous analyses of material sent on for examination.

XV. Water analyses.

XVI. Compilation of fodder analyses, with reference to fodder constituents and fertilizing constituents; analyses of industrial products, garden crops, fruits, etc., made at Amherst, Mass.

XVII. Meteorological observations.

The periodical publications of the station have been as numerous as in previous years. The circulation of bulletins and annual reports is steadily increasing.

In closing, it becomes a pleasing duty to acknowledge that the successful termination of the work carried on at the station during the past year is largely due to the industry and faithful execution of the various tasks assigned to all parties associated with me for that purpose.

With the assurance of my sincere thanks for your kind indulgence, permit me to sign,

Yours very respectfully,

C. A. GOESSMANN,

Director of the Massachusetts Agricultural Experiment Station.

Amherst, Mass., Jan. 9, 1891.

ON FEEDING EXPERIMENTS.
1890.

I. Two Feeding Experiments with Milch Cows.
II. One Feeding Experiment with Lambs.
III. Two Feeding Experiments with Pigs.
IV. Fodder Analyses.

I.

1. Some general remarks on our previous feeding experiments with milch cows. 2. Feeding experiments with milch cows, to compare the value of old-process linseed meal with that of new-process linseed meal, when fed pound for pound under otherwise corresponding conditions. 3. Feeding experiments with milch cows, to compare the economical value of reputed fodder crops, — vetch and oats, and soja bean, — when fed as green fodder in part or in whole as substitutes for English hay. 4. Creamery record for 1889 and 1890.

1. Some General Remarks on our Previously Reported Feeding Experiments with Milch Cows.

A careful examination of our last annual report cannot fail to show that our feeding experiments with milch cows, previous to the close of 1889, were chiefly instituted for the purpose of securing a satisfactory answer to the following questions: —

1. What is the comparative feeding effect of dry fodder corn, of dry corn stover, and of a good corn ensilage, when used in part or in the whole as a substitute for English hay (upland meadow hay), in the daily diet of milch cows, and also that of a good root crop in place of corn ensilage; the amount and kind of grain feed remaining, for obvious reasons, the same under otherwise corresponding circumstances?

2. What is the *total cost*, as well as the *net cost*, of the *daily feed* per head in case of the different fodder combinations used; making in all cases alike an allowance of a loss of twenty per cent. of the fertilizing constituents contained in the feed consumed, in consequence of the sale of the milk?

3. What is the commercial value, at current market rates, of the manurial refuse obtainable in the case of different fodder combinations used as daily diet for the support of cows, assuming that eighty per cent. of the value of the fertilizing constituents contained in the fodder consumed can be secured to the farm by a careful management?

The results of these experiments, which extend over a period of five successive years, 1885–89, were summed up in the following statements: —

1. The high nutritive value of fodder corn, corn stover and good corn ensilage, as compared with that of English hay, counting in all instances pound for pound of dry vegetable matter, is fully confirmed. The general condition of the animal on trial, as well as the quality and the quantity of the milk obtained, point in that direction.

2. To produce one quart of milk, using the same quantity and quality of grain feed, required in every instance a larger quantity of perfectly dried hay than of either fodder corn, corn stover or corn ensilage, in a corresponding state of dryness, — corn stover leading.

3. The net cost of feed in the case of the same ration of grain feed is from one-third to one-half less per quart of milk, when fodder corn, corn stover or corn ensilage serve as substitutes for English hay in the daily diet of milch cows; corn fodder, as a rule, leading, while corn stover leads the corn ensilage in four out of six cases.

4. Sugar beets, as well as carrots, when fed pound for pound of dry matter in place of part of the hay ration, with the same kind and quantity of grain feed, have raised almost without an exception the temporary yield of milk; exceeding, as a rule, the corn ensilage in that direction.

5. Corn ensilage, as well as roots, proved best when fed in place of one-fourth to one-half of the full hay ration. From twenty-five to twenty-seven pounds of roots, or from

thirty-five to forty pounds of corn ensilage per day, with all the hay called for to satisfy the animal in either case, seems, for various reasons, a good proportion, allowing the stated kind and quantity of grain feed.

6. The influence of the various diets used on the quality of the milk seems to depend in a controlling degree on the constitutional characteristics of the animal on trial. The effect is not unfrequently in our case the reverse in different animals depending on the same diet. The increase in the quantity of milk is frequently accompanied by a decrease in solids.

The valuation of the fodder ingredients is based in this connection on the average of the local market price per ton of each article for the entire period of observation : —

Corn meal,	$22 75	Fodder corn,	$5 00
Wheat bran,	21 00	Corn stover,	5 00
Gluten meal,	24 50	Corn ensilage,	2 75
Hay,	15 00	Carrots,	7 00
Rowen,	15 00	Sugar beets,	5 00

The commercial valuation of the fertilizing constituents contained in each fodder article is based on the following market prices : *i. e.*, nitrogen (per pound), 17 cents ; phosphoric acid, 6 cents ; and potassium oxide, 4¼ cents. Eighty per cent. of the entire amount of fertilizing constituents contained in the fodder consumed is considered obtainable by proper management, while twenty per cent. is assumed to be sold with the milk.

For further details, see seventh annual report of station, pages 37–47, and 73–84.

It will be apparent, from the above statements, that it was the main aim of our feeding experiments with milch cows, during the years 1885–89, to compare the relative feeding value of our *current coarse fodder articles* with each other, — as, English hay, rowen, fodder corn, corn stover, corn ensilage and roots. To do this judiciously required in all cases the use of the same quantity and quality of grain feed. It is for this reason chiefly that the latter was confined to the same quantity of corn meal, corn and cob meal, wheat bran and gluten meal.

These articles were at any time at our disposal in our local market; all of them could claim a fair reputation for milk production.

During the past year *we have changed the object of our feeding experiments* with milch cows. Having made ourselves, as far as practicable, familiar with the feeding effect and general economical value of our current *coarse home-raised fodder articles*, it was decided to compare the feeding value of our prominent concentrated fodder articles (grains, brans, oilcakes, gluten meal, starch feed, etc.) with each other, under otherwise corresponding circumstances.

Some experiments with the two kinds of linseed meal (old and new process) are described within a few subsequent pages.

2. *Feeding Experiments with Milch Cows.*

Old-process linseed meal *vs.* new-process linseed meal, Dec. 11; 1889–July 2, 1890.

The feeding experiments subsequently described were instituted chiefly for the purpose of comparing the effect of new-process linseed meal with that of old-process linseed meal, on the *quantity* and *quality* of milk produced, and on *the cost of feed* consumed, when fed *in equal weights* as an ingredient of an otherwise corresponding daily diet of milch cows. This inquiry into the respective merits of both kinds of linseed meal for dairy purposes has been undertaken in response to frequent inquiries regarding that point on the part of dairymen in our State. The old-process linseed meal is sold, in our local markets, at $27 per ton of 2,000 pounds, and the new-process linseed meal of the Cleveland Linseed Oil Company at $26 for the same weight. The first-named article is obtained when the seed is subjected to the action of a powerful press to secure its oil; while the latter is produced by the aid of a new process, owned by the Cleveland company. The new process favors a more thorough abstraction of the oil, and involves, it is stated, a boiling of the seeds. The difference in the treatment of the seed, for the separation of the oil, explains one of the most characteristic differences in the composition of both kinds of linseed meal; for old-process linseed meal

contains, as a rule, a larger percentage of oil or fat, and a smaller one of organic-nitrogen-containing matter, than the new-process linseed meal. Aside from the stated causes of differences in their composition, there are various other circumstances which not unfrequently contribute towards serious variations in the composition of individual samples of both kinds. Among these is most prominent a more or less advanced state of maturity of the plant when harvested. Our inquiry into the comparative value of both kinds of meal as a fodder ingredient of the daily diet for milch cows has been carried on with articles of the following average composition: —

COMPOSITION OF LINSEED MEAL USED.	New-process Linseed Meal.	Old-process Linseed Meal.
	Per Cent.	Per Cent.
Moisture at 100° C.,	5.06	9.88
Dry matter,	94.94	90.12
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	6.34	7.39
" cellulose,	8.93	8.74
" fat,	2.17	7.24
" protein (nitrogenous matter),	41.02	36.97
Non-nitrogenous extract matter,	41.54	39.66
	100.00	100.00

Fertilizing Constituents.

	Per Cent.	Per Cent.
Moisture at 100° C.,	5.06	9.88
Nitrogen,	6.25	5.33
Phosphoric acid,	1.42	1.64
Potassium oxide,	1.16	1.16
Valuation per ton of 2,000 pounds,	$24 00	$21 50

Five cows, grades of various description, all of fair milking qualities, were selected for the trial. Two had dropped their last calves one month before the beginning of the observation, one five months, and two from eleven to twelve months. They differed but one year in their respective ages, which were from six to seven years.

English hay, rowen, fodder corn, corn stover, corn ensilage, carrots and sugar beets furnished at different times the main bulk of the daily fodder ration; while corn meal, wheat bran and both kinds of linseed meal alternately served as supplementary feed stuffs to secure a desired high nutritive character for the entire diet. The daily quantity of the grain feed, of roots and of hay, in case corn ensilage furnished largely the coarse feed, was in each case a definite one, decided upon before; it was in each case entirely consumed. The daily consumption of the coarse portion of the particular fodder combination on trial, as hay when fed alone, rowen, fodder corn, corn stover and corn ensilage, depended on the appetite of each individual animal. It varied usually somewhat in quantity in case of different cows. Care was taken to offer to each a liberal quantity. The unconsumed portion was weighed back each day, and subsequently accounted for in the daily feeding record.

The fodder corn, corn ensilage and corn stover were obtained from the same variety of corn, "Pride of the North," a dent corn. The ensilage corn and the fodder corn were of a corresponding stage of growth; *i.e.*, with kernel beginning to glaze. The corn stalks were in every case cut into pieces from one and one-half to two inches in length before being fed.

The entire experiment extended over six successive months, and was subdivided into nine distinct periods. The changes in daily diet were made gradually, as customary in well-conducted feeding experiments. The weekly weights of the animals on trial were taken on the same day, in the morning, before milking and feeding.

The adopted valuation of the different fodder articles is based on their local market price per ton of 2,000 pounds, at Amherst: —

Corn meal, per ton,	$19 00
Wheat bran,	17 50
Old-process linseed meal,	27 00
New-process linseed meal,	26 00
Carrots,	7 00
Sugar beets,	5 00
Hay,	15 00
Rowen,	15 00
Fodder corn,	5 00
Corn stover,	5 00
Corn ensilage,	2 75

A few subsequent pages contain an abstract of the results of the experiment, closing with a detailed feeding record of every cow on trial: —

I. — *Statement of the Average of the Daily Fodder Combinations used during the Different Successive Feeding Periods.*

I.		II.	
Corn meal (pounds),	3.25	Corn meal (pounds),	3.25
Wheat bran,	3.25	Wheat bran,	3.25
Old-process linseed meal,	3.25	Old-process linseed meal,	3.25
Hay,	18.50	Hay,	5.00
Total cost (cents),	24.18	Corn ensilage,	45.00
Net cost,	14.06	Total cost (cents),	20.25
Manurial value obtainable,	10.12	Net cost,	10.79
Nutritive ratio,	1 : 5.73	Manurial value obtainable,	9.46
		Nutritive ratio,	1 : 6.27

III.		IV.	
Wheat bran (pounds),	3.25	Wheat bran (pounds),	3.25
Old-process linseed meal,	3.25	Old-process linseed meal,	3.25
Carrots,	20.00	Carrots,	20.00
Fodder corn,	13.75	Corn stover,	16.00
Total cost (cents),	17.65	Total cost (cents),	18.21
Net cost,	9.58	Net cost,	9.20
Manurial value obtainable,	8.07	Manurial value obtainable,	9.01
Nutritive ratio,	1 : 5.16	Nutritive ratio,	1 : 5.15

I. — *Daily Fodder Combinations* — Concluded.

V.		VI.	
Wheat bran (pounds),	3.25	Corn meal (pounds),	3.25
New-process linseed meal,	3.25	Wheat bran,	3.25
Carrots,	20.00	New-process linseed meal,	3.25
Fodder corn,	16.25	Sugar beets,	20.00
Total cost (cents),	18.06	Hay,	16.00
Net cost,	9.12	Total cost (cents),	27.16
Manurial value obtainable,	8.94	Net cost,	16.38
Nutritive ratio,	1 : 4.96	Manurial value obtainable,	10.78
		Nutritive ratio,	1 : 5.23

VII.		VIII.	
Corn meal (pounds),	3.25	Corn meal (pounds),	3.25
Wheat bran,	3.25	Wheat bran,	3.25
Old-process linseed meal,	3.25	Old-process linseed meal,	3.25
Sugar beets,	20.00	Rowen,	20.75
Hay,	16.00	Total cost (cents),	25.86
Total cost (cents),	27.30	Net cost,	13.48
Net cost,	16.96	Manurial value obtainable,	12.38
Manurial value obtainable,	10.34	Nutritive ratio,	1 : 5.04
Nutritive ratio,	1 : 5.63		

IX.

Corn meal (pounds),	3.25
Wheat bran,	3.25
New-process linseed meal,	3.25
Rowen,	20.75
Total cost (cents),	25.72
Net cost,	13.05
Manurial value obtainable,	12.67
Nutritive ratio,	1 : 4.73

II. — *Summary of the Cost of the Daily Fodder Rations (Cents).*

	PERIODS.								
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
Total cost,	24.18	20.25	17.65	18.21	18.06	27.16	27.30	25.86	25.72
Net cost,	14.06	10.79	9.58	9.20	9.12	16.38	16.96	13.48	13.05
Manurial value obtainable,	10.12	9.46	8.07	9.01	8.94	10.78	10.34	12.38	12.67

II. — *Daily Fodder Rations* — Concluded.

Valuation of Essential Fertilizing Constituents in the Various Fodder Articles used.

Nitrogen, 17 cents per pound; phosphoric acid, 6 cents; potassium oxide, 4½ cents.

	Corn Meal.	Wheat Bran.	Old-process Oil Meal.	New-process Oil Meal.	Hay.	Corn Ensilage.	Fodder Corn.	Corn Stover.	Carrots.	Sugar Beets.	Rowen.
Moisture, . .	11.67	9.27	9.88	5.06	9.72	72.95	20.42	22.50	90.47	90.02	13.53
Nitrogen, . .	1.479	2.545	5.331	6.254	1.379	0.33	1.058	1.211	0.149	0.184	1.790
Phosphoric acid, .	0.713	2.900	1.646	1.420	0.359	0.138	0.510	0.303	0.100	0.086	0.464
Potassium oxide, .	0.430	1.637	1.162	1.160	1.572	0.301	0.760	1.320	0.540	0.462	1.966
Value per 2,000 lbs.,	$6 27	$13 60	$21 15	$24 00	$6 53	$1 56	$4 89	$5 67	$1 12	$1 14	$8 42

III. — *Amount of Dry Vegetable Matter of the Feed required to produce One Quart of Milk during the Experiment.*

NAME.	Average Yield of Milk per Day (Quarts).	Average Amount of Dry Matter consumed to produce One Quart of Milk.
Juno, ...	9.53	2.57
Flora, ...	7.46	3.17
Jessie, ...	7.40	3.09
Roxy, ...	12.55	1.99
Pink, ...	10.99	2.09

IV. — *Cost of Feed consumed for the Production of One Quart of Milk during the Different Feeding Periods (Cents).*

Feeding Periods, 1889-1890.		Juno.	Flora.	Jessie.	Roxy.	Pink.
I. Dec. 11 to Dec. 31, . .	Total cost, . .	2.54	2.88	3.08		
	Net cost, . .	1.48	1.68	1.79		
	Obtainable manure,	1.06	1.20	1.29		
II. Jan. 6 to Feb. 16, . . .	Total cost, . .	2.20	2.52	2.83		
	Net cost, .	1.17	1.34	1.51		
	Obtainable manure,	1.03	1.18	1.32		

IV. — *Cost of Feed, etc.* — Concluded.

Feeding Periods, 1889-1890.		Juno.	Flora.	Jessie.	Roxy.	Pink.
III. Feb. 23 to March 13,	Total cost,	2 19	3.00	2.85	1.37	1.61
	Net cost,	1.15	1 65	1.57	.72	.87
	Obtainable manure,	1.04	1.35	1.28	0.65	0.74
IV. March 18 to April 5,	Total cost,	2 24	2.81	2.72	1.63	1.76
	Net cost,	1.13	1.43	1.39	.81	.87
	Obtainable manure,	1.11	1.38	1.33	0.82	0.89
V. April 9 to April 18,	Total cost,	2.19	2.47	2.37	1.60	1.68
	Net cost,	1.11	1.25	1.21	.79	.85
	Obtainable manure,	1.08	1.22	1.16	0.81	0.83
VI. April 25 to May 13,	Total cost,	2.72	3.36	3.36	2.12	2.45
	Net cost,	1.64	2.02	2.02	1.60	1.48
	Obtainable manure,	1.08	1.34	1.34	0.52	0.97
VII. May 18 to May 27,	Total cost,	2.71	3.48	3.45	2.24	2 46
	Net cost,	1.69	2.16	2.14	1.39	1.53
	Obtainable manure,	1.02	1.32	1.31	0.85	0.93
VIII. June 1 to June 19,	Total cost,	2.38	3.19	3.10	2.10	2.17
	Net cost,	1.25	1.67	1.62	1.11	1.10
	Obtainable manure,	1.13	1.52	1.48	0.99	1.07
IX. June 23 to July 2,	Total cost,	2.49	3.59	3.09	2.12	2.24
	Net cost,	1.26	1 82	1.57	1.11	1.14
	Obtainable manure,	1.23	1.77	1.52	1.01	1.10

V. — *Average Quantity of Milk per Day (Quarts).*

	Feeding Periods, 1889-1890.								
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
Juno,	9.67	9.40	8.47	8.18	8.30	10.04	10.06	11.05	10.61
Flora,	8.64	8.41	5.73	6.45	7.26	7.86	7.64	7.89	7.29
Jessie,	7.87	7.16	6.05	6.57	7.44	7.75	7.48	8.19	8.09
Roxy,			13.52	11.46	11.64	13.18	12.67	12.84	12.22
Pink,			10.09	10.59	10.65	11.30	11.05	12.06	11.19

V. — *Average Quantity of Milk, etc.* — Concluded.

I. — Variations in daily production of milk during the entire feeding experiment (quarts).

II. — Average quantity of milk per day for the entire feeding experiment (quarts).

	I.	II.
Juno,	8.18 — 11.05	9.53
Flora,	5.73 — 8.64	7.46
Jessie,	6.05 — 8.19	7.40
Roxy,	11.46 — 13.52	12.55
Pink,	10.09 — 12.06	10.99

VI. — *Statement of the Average of Analyses of Milk made during the Different Feeding Periods.*

Periods.		Juno.	Flora.	Jessie.	Roxy.	Pink.
I.,	Solids, per cent.,	12.84	13.47	14.72		
	Fat, per cent.,	3.89	3.72	5.21		
II.,	Solids, per cent,	12.97	13.86	14.93		
	Fat, per cent.,	3.93	4.33	5.86		
III.,	Solids, per cent.,	13.68	15.44	15.61	13.27	14.86
	Fat, per cent.,	4.33	6.00	6.45	4.21	5.73
IV.,	Solids, per cent,	13.80	13.62	14.14	13.18	13.61
	Fat, per cent.,	4.31	4.27	4.78	3.51	4.72
V.,	Solids, per cent,	13.34	12.59	13.79	12.48	13.65
	Fat, per cent.,	4.24	3.96	5.17	4.30	4.74
VI.,	Solids, per cent,	14.37	13.30	14.93	13.21	14.45
	Fat, per cent.,	4.76	3.71	5.57	3.91	5.02
VII.,	Solids, per cent.,	13.90	13.19	15.76	12.74	14.40
	Fat, per cent.,	4.28	3.85	6.22	3.75	5.11
VIII.,	Solids, per cent,	13.62	12.82	14.80	12.59	14.20
	Fat, per cent.,	4.59	3.73	5.70	3.73	5.04
IX.,	Solids, per cent.,	13.85	12.93	14.43	12.81	14.40
	Fat, per cent.,	4.45	3.52	5.13	3.68	3.93

VII. — *Creamery Record for the Different Feeding Periods.*

Feeding Periods.		Quarts of Milk set for Cream.	Spaces of Cream produced.	Average Number of Spaces per Day.	Quarts of Milk produced One Space of Cream.
	1889-1890.				
I.	Dec. 11 to Dec. 31, .	933.50	657	31.29	1.42
II.	Jan. 6 to Feb. 16, .	2,013.40	1,367	32.55	1.47
III.	Feb. 23 to March 13,	913.74	602	31.68	1.52
IV.	March 18 to April 5,	1,002.75	627	33.00	1.60
V.	April 9 to April 18, .	559.50	336	33.60	1.67
VI.	April 25 to May 13, .	1,159.50	665	35.00	1.74
VII.	May 18 to May 27, .	599.20	347	34.70	1.73
VIII.	June 1 to June 19, .	1,201.50	676	35.58	1.76
IX.	June 23 to July 2, .	601.25	333	33.30	1.81

VIII. — *Live Weights of Animals during the Feeding Periods (Pounds).*

Name.	Feeding Periods.									Gain at Close.
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	
Juno, ...	1,070	1,030	1,018	1,025	1,042	1,095	1,095	1,142	1,125	55
Flora, ...	1,000	990	960	984	1,005	1,047	1,050	1,084	1,080	80
Jessie, ...	888	870	827	830	838	901	897	932	928	40
Roxy, ...			834	849	864	898	915	955	938	104
Pink, ...			800	814	818	860	860	852	859	59

IX. — *Conclusion.*

An examination of the previously recorded results of the inquiry into the respective particular claims of both kinds of linseed meal as food constituents for dairy purposes shows that, *at stated market prices*, under *otherwise corresponding circumstances* and when *used in equal-weight parts*, they may serve in place of each other without materially affecting the financial side of the operation one way or the

other. In case the new-process linseed meal is used, the net cost of the milk is somewhat less, on account of the larger amount of fertilizing elements it contains, which increases somewhat the value of obtainable manure (see rations 6, 7, 8 and 9). This advantage is, however, in the majority of instances, to some extent compensated for by a somewhat more liberal yield of milk, in case old-process linseed meal has been fed. As the old-process linseed meal has a well-established reputation as a suitable food constituent for dairy cows, the new-process linseed meal may claim a similar position in the front rank of concentrated feed stuffs for dairy purposes. A careful selection of suitable associated fodder constituents is, however, in both instances, necessary to show their real economical value. A comparison of the yield of milk obtained, in the majority of cases, during feeding periods III., IV., with those of periods VI., VII., VIII. and IX., cannot fail to render that point prominent.

X. — *Detailed Statement of the Feeding Record of the Different Cows on Trial.*

1. JUNO: *Age, seven years; grade, Ayrshire; last calf, June 22, 1889.*

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.											Amount of Dry Vegetable Matter contained in the Daily Fodder consumed (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Period (Pounds).
	Corn Meal.	Wheat Bran.	Old-process Linseed Meal.	New-process Linseed Meal.	Hay.	Corn Ensilage.	Fodder Corn.	Corn Stover.	Carrots.	Sugar Beets.	Rowen.					
1889 - 1890.																
Dec. 11 to Dec. 31,	3 25	3.25	3.25	–	18 95	–	–	–	–	–	–	25.84	9.67	2.67	1 : 5.76	1,070
Jan. 6 to Feb. 16,	3.25	3.25	3.25	–	5.00	47.81	–	–	–	–	–	26.17	9.40	2.78	1 : 6.36	1,030
Feb. 23 to March 13,	–	3.25	3.25	–	–	–	17.53	–	20.00	–	–	21.72	8.47	2.56	1 : 5.51	1,018
March 18 to April 5,	–	3.25	3.25	–	–	–	–	16.32	20.00	–	–	20.42	8.18	2.50	1 : 5.17	1,025
April 9 to April 18,	–	3 25	–	3.25	–	–	16.75	–	20.00	–	–	21.26	8.30	2.56	1 : 5.01	1,042
April 25 to May 13,	3.25	3.25	–	3.25	16.11	–	–	–	–	20.00	–	25.43	10.04	2.53	1 : 5.24	1,095
May 18 to May 27,	3.25	3.25	3.25	–	16.00	–	–	–	–	20.00	–	25.17	10.06	2 50	1 : 5.63	1,095
June 1 to June 19,	3.25	3 25	3.25	–	–	–	–	–	–	–	21.34	27.18	11.05	2.46	1 : 5.08	1,142
June 23 to July 2,	3 25	3 25	–	3.25	–	–	–	–	–	–	21.70	27.65	10.61	2.61	1 : 4.77	1,125

2. FLORA: *Age, six years; grade, Durham; last calf, Dec. 22, 1888.*

Dec. 11 to Dec. 31,	3.25	3.25	3.25	–	19.43	–	–	–	–	–	–	26.27	8.64	3.04	1 : 5.79	1,000
Jan. 6 to Feb. 16,	3.25	3.25	3.25	–	5.00	51.17	–	–	–	–	–	27.08	8.41	3.22	1 : 6.44	990
Feb. 23 to March 13,	–	3.25	3 25	–	–	–	11 95	–	20.00	–	–	17.28	5.73	3.02	1 : 4.96	960
March 18 to April 5,	–	3.25	3.25	–	–	–	–	15.74	20.00	–	–	19.97	6.45	3.09	1 : 5.13	984
April 9 to April 18,	–	3.25	–	3.25	–	–	15.70	–	20.00	–	–	20.42	7.26	2.81	1 : 4.91	1,005
April 25 to May 13,	3.25	3.25	–	3.25	15.00	–	–	–	–	20.00	–	24.43	7.86	3.11	1 : 5.16	1,047
May 18 to May 27,	3.25	3.25	3 25	–	15.00	–	–	–	–	20.00	–	24.27	7.64	3.18	1 : 5.55	1,050
June 1 to June 19,	3.25	3.25	3.25	–	–	–	–	–	–	–	19.79	25.84	7.89	3.28	1 : 5.01	1,084
June 23 to July 2,	3.25	3.25	–	3.25	–	–	–	–	–	–	21.40	27.39	7.29	3.76	1 : 4.75	1,080

FEEDING RECORD — *Continued.*

3. JESSIE: *Age, six years; grade, Jersey; last calf, Jan. 12, 1889.*

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.											Amount of Dry Vegetable Matter contained in the Daily Fodder consumed (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Period (Pounds).
	Corn Meal.	Wheat Bran.	Old-process Linseed Meal.	New-process Linseed Meal.	Hay.	Corn Ensilage.	Fodder Corn.	Corn Stover.	Carrots.	Sugar Beets.	Rowen.					
1889-1890.																
Dec. 11 to Dec. 31,	3.25	3.25	3.25	–	18.43	–	–	–	–	–	–	25.37	7.87	3.22	1:5.72	888
Jan. 6 to Feb. 16,	3.25	3.25	3.25	–	5.00	45.02	–	–	–	–	–	25.42	7.16	3.55	1:6.27	870
Feb. 23 to March 13,	–	3.25	3.25	–	–	–	12.21	–	20.00	–	–	17.49	6.05	2.89	1:5.00	827
March 18 to April 5,	–	3.25	3.25	–	–	–	–	14.47	20.00	–	–	18.98	6.57	2.89	1:5.02	830
April 9 to April 18,	–	3.25	–	3.25	–	–	14.30	–	20.00	–	–	19.31	7.44	2.60	1:4.78	838
April 25 to May 13,	3.25	3.25	–	3.25	14.53	–	–	–	–	20.00	–	24.01	7.75	3.10	1:5.12	901
May 18 to May 27,	3.25	3.25	3.25	–	14.00	–	–	–	–	20.00	–	23.37	7.48	3.12	1:5.47	897
June 1 to June 19,	3.25	3.25	3.25	–	–	–	–	–	–	–	20.16	26.16	8.19	3.19	1:5.02	932
June 23 to July 2,	3.25	3.25	–	3.25	–	–	–	–	–	–	19.90	26.09	8.09	3.22	1:4.69	928

4. ROXY: *Age, seven years; grade, Ayrshire; last calf, Feb. 5, 1890.*

Feb. 23 to March 13,	–	3.25	3.25	–	–	–	17.21	–	20.00	–	–	21.47	13.52	1.59	1:5.48	834
March 18 to April 5,	–	3.25	3.25	–	–	–	–	18.11	20.00	–	–	21.81	11.46	1.90	1:5.30	849
April 9 to April 18,	–	3.25	–	3.25	–	–	18.30	–	20.00	–	–	22.49	11.64	1.93	1:5.15	864
April 25 to May 13,	3.25	3.25	–	3.25	17.05	–	–	–	–	20.00	–	26.28	13.18	1.99	1:5.31	898
May 18 to May 27,	3.25	3.25	3.25	–	17.40	–	–	–	–	20.00	–	26.44	12.67	2.09	1:5.73	915
June 1 to June 19,	3.25	3.25	3.25	–	–	–	–	–	–	–	22.16	27.89	12.84	2.17	1:5.11	955
June 23 to July 2,	3.25	3.25	–	3.25	–	–	–	–	–	–	21.90	27.83	12.22	2.28	1:4.81	938

FEEDING RECORD — *Concluded.*

5. PINK : *Age, six years; native; last calf, Jan. 23, 1890.*

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.											Amount of Dry Vegetable Matter contained in the Daily Fodder consumed (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Period (Pounds).
	Corn Meal.	Wheat Bran.	Old-process Linseed Meal.	New-process Linseed Meal.	Hay.	Corn Ensilage.	Fodder Corn.	Corn Stover.	Carrots.	Sugar Beets.	Rowen.					
1890.																
Feb. 23 to March 13,	–	3.25	3.25	–	–	–	11.05	–	17.90	–	–	16.36	10.09	1.62	1 : 4.87	800
March 18 to April 5,	–	3.25	3.25	–	–	–	–	17.74	20.00	–	–	21.52	10.59	2.03	1 : 5.27	814
April 9 to April 18,	–	3.25	–	3.25	–	–	15.60	–	20.00	–	–	20.34	10.65	1.91	1 : 4.90	818
April 25 to May 13,	3.25	3.25	–	3.25	16.79	–	–	–	–	20.00	–	26.05	11.30	2.31	1 : 5.29	860
May 18 to May 27,	3.25	3.25	3.25	–	15.80	–	–	–	–	20.00	–	24.99	11.05	2.26	1 : 5 61	860
June 1 to June 19,	3.25	3.25	3.25	–	–	–	–	–	–	–	20.37	26.34	12.06	2.18	1 : 5.02	852
June 23 to July 2,	3.25	3.25	–	3 25	–	–	–	–	–	–	20.00	26.18	11.19	2.34	1 : 4.69	859

6. NANCY : *Age, seven years; native; last calf, March 16, 1890.*

March 25 to April 5,	–	3.25	3 25	–	–	–	–	13.50	20.00	–	–	18.23	12.70	1.44	1 : 4.94	860
May 18 to May 27,	3.25	3.25	3 25	–	15.80	–	–	–	–	20.00	–	24.99	13.02	1.92	1 : 5.61	875
June 1 to June 19,	3.25	3.25	3.25	–	–	–	–	–	–	–	19.76	25.82	13.21	1.95	1 : 5.01	900
June 23 to July 2,	3.25	3.25	–	3.25	–	–	–	–	–	–	19.70	25.93	12.74	2.04	1 : 4.67	889

TOTAL COST OF FEED PER QUART OF MILK.

I. Jane.

FEEDING PERIODS.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Old-process Linseed Meal consumed (Pounds).	Total Amount of New-process Linseed Meal consumed (Pounds).	Total Amount of Hay consumed (Pounds).	Total Amount of Corn Ensilage consumed (Pounds).	Total Amount of Fodder Corn consumed (Pounds).	Total Amount of Corn Stover consumed (Pounds).	Total Amount of Carrots consumed (Pounds).	Total Amount of Sugar Beets consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
1889-1890.															
Dec. 11 to Dec. 31,	203.02	9.67	68.25	68.25	68.25	—	398.00	—	—	—	—	—	—	$5 16	2.54
Jan. 6 to Feb. 16,	394.88	9.40	136.50	136.50	136.50	—	210.00	2,008.00	—	—	—	—	—	8 68	2.20
Feb. 23 to March 13,	160.93	8.47	—	61.75	61.75	—	—	—	333.00	—	380.00	—	—	3 53	2.19
March 18 to April 5,	155.35	8.18	—	61.75	61.75	—	—	—	—	310.00	380.00	—	—	3 48	2.24
April 9 to April 18,	83.02	8.30	—	32.50	—	32.50	—	—	167.50	—	200.00	—	—	1 82	2.19
April 25 to May 13,	190.70	10.04	61.75	61.75	—	61.75	306.00	—	—	—	—	380.00	—	5 18	2.72
May 18 to May 27,	100.58	10.06	32.50	32.50	32.50	—	160.00	—	—	—	—	200.00	—	2 73	2.71
June 1 to June 19,	209.88	11.05	61.75	61.75	61.75	—	—	—	—	—	—	—	405.50	5 00	2.38
June 23 to July 2,	106.05	10.61	32.50	32.50	—	32.50	—	—	—	—	—	—	217.00	2 64	2.49

TOTAL COST OF FEED PER QUART OF MILK — *Continued.*

2. Flora.

FEEDING PERIODS.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Old-process Linseed Meal consumed (Pounds).	Total Amount of New-process Linseed Meal consumed (Pounds).	Total Amount of Hay consumed (Pounds).	Total Amount of Corn Ensilage consumed (Pounds).	Total Amount of Fodder Corn consumed (Pounds).	Total Amount of Corn Stover consumed (Pounds).	Total Amount of Carrots consumed (Pounds).	Total Amount of Sugar Beets consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
1889-1890.															
Dec. 11 to Dec. 31,	181.50	8.64	68 25	68.25	68.25	–	408.00	–	–	–	–	–	–	$5 23	2.88
Jan. 6 to Feb. 16,	353.02	8.41	136.50	136.50	136.50	–	210.00	2,149.00	–	–	–	–	–	8 88	2.52
Feb. 23 to March 13,	108.84	5.73	–	61.75	61.75	–	–	–	227.00	–	380.00	–	–	3 27	3 00
March 18 to April 5,	122 56	6.45	–	61.75	61.75	–	–	–	–	299 00	380.00	–	–	3 45	2.81
April 9 to April 18,	72.56	7.26	–	32 50	–	32.50	–	–	157.00	–	200.00	–	–	1 79	2.47
April 25 to May 13,	149 32	7.86	61.75	61.75	–	61.75	285.00	–	–	–	–	380.00	–	5 02	3.36
May 18 to May 27,	76.40	7.64	32.50	32 50	32.50	–	150.00	–	–	–	–	200.00	–	2 66	3 48
June 1 to June 19,	150.00	7.89	61.75	61.75	61.75	–	–	–	–	–	–	–	376.00	4 78	3.19
June 23 to July 2,	72.91	7.29	32.50	32 50	–	32.50	–	–	–	–	–	–	214.00	2 62	3.59

TOTAL COST OF FEED PER QUART OF MILK — *Continued.*

3. Jessie.

FEEDING PERIODS.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Old-process Linseed Meal consumed (Pounds).	Total Amount of New-process Linseed Meal consumed (Pounds).	Total Amount of Hay consumed (Pounds).	Total Amount of Corn Ensilage consumed (Pounds).	Total Amount of Fodder Corn consumed (Pounds).	Total Amount of Corn Stover consumed (Pounds).	Total Amount of Carrots consumed (Pounds).	Total Amount of Sugar Beets consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
1889-1890.															
Dec. 11 to Dec. 31,	165.25	7.87	68.25	68.25	68.25	–	387.00	–	–	–	–	–	–	$5 07	3.08
Jan. 6 to Feb. 16,	300.70	7.16	136.50	136.50	136.50	–	210.00	1,891.00	–	–	–	–	–	8 52	2.83
Feb. 23 to March 13,	115.00	6.05	–	61.75	61.75	–	–	–	232.00	–	380.00	–	–	3 28	2.85
March 18 to April 5,	124.75	6.57	–	61.75	61.75	–	–	–	–	275.00	380.00	–	–	3 39	2.72
April 9 to April 18,	74.40	7.44	–	32.50	–	32.50	–	–	143.00	–	200.00	–	–	1 76	2.37
April 25 to May 13,	147.25	7.75	61.75	61.75	–	61.75	276.00	–	–	–	–	380.00	–	4 95	3.36
May 18 to May 27,	74.77	7.48	32.50	32.50	32.50	–	140.00	–	–	–	–	200.00	–	2 58	3.45
June 1 to June 19,	155.70	8.19	61.75	61.75	61.75	–	–	–	–	–	–	–	383.00	4 83	3.10
June 23 to July 2,	80.93	8.09	32.50	32.50	–	32.50	–	–	–	–	–	–	199.00	2 50	3.09

4. Roxy.

Feb. 23 to March 13,	256.86	13.52	–	61.75	61.75	–	–	–	327.00	–	380.00	–	–	$3 52	1.37
March 18 to April 5,	217.75	11.46	–	61.75	61.75	–	–	–	–	344.00	380.00	–	–	3 56	1.63
April 9 to April 18,	116.40	11.64	–	32.50	–	32.50	–	–	183.00	–	200.00	–	–	1 86	1.60
April 25 to May 13,	250.35	13.18	61.75	61.75	–	61.75	324.00	–	–	–	–	380.00	–	5 31	2.12
May 18 to May 27,	126.74	12.67	32.50	32.50	32.50	–	174.00	–	–	–	–	200.00	–	2 84	2.24
June 1 to June 19,	243.95	12.84	61.75	61.75	61.75	–	–	–	–	–	–	–	421.00	5 12	2.10
June 23 to July 2,	122.21	12.22	32.50	32.50	–	32.50	–	–	–	–	–	–	219.00	2 65	2.17

TOTAL COST OF FEED PER QUART OF MILK — *Concluded.*

5. Pink.

FEEDING PERIODS.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Old-process Linseed Meal consumed (Pounds).	Total Amount of New-process Linseed Meal consumed (Pounds).	Total Amount of Hay consumed (Pounds).	Total Amount of Corn Ensilage consumed (Pounds).	Total Amount of Fodder Corn consumed (Pounds).	Total Amount of Corn Stover consumed (Pounds).	Total Amount of Carrots consumed (Pounds).	Total Amount of Sugar Beets consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
1890.															
Feb. 23 to March 13,	191.74	10.09	–	61.75	61.75	–	–	–	210.00	–	340.00	–	–	$3 09	1 61
March 18 to April 5,	201.16	10.59	–	61.75	61.75	–	–	–	–	337.00	380.00	–	–	3 54	1.76
April 9 to April 18,	106.51	10.65	–	32.50	–	32 50	–	–	156.00	–	200.00	–	–	1 79	1 68
April 25 to May 13,	214.75	11.30	61.75	61.75	–	61.75	319.00	–	–	–	–	380.00	–	5 27	2.45
May 18 to May 27,	110.47	11.05	32 50	32.50	32.50	–	158.00	–	–	–	–	200.00	–	2 72	2.46
June 1 to June 19,	229.07	12 06	61.75	61.75	61.75	–	–	–	–	–	–	–	387.00	4 86	2.12
June 23 to July 2,	111.86	11.19	32.50	32.50	–	32.50	–	–	–	–	–	–	200.00	2 51	2.24

6. Nancy.

March 25 to April 5,	152.44	12.70	–	39.00	39.00	–	–	–	–	162.00	240.00	–	–	$2 12	1.39
May 18 to May 27,	130.23	13.02	32.50	32.50	32.50	–	158.00	–	–	–	–	200.00	–	2 72	2.09
June 1 to June 19,	250.93	13.21	61.75	61 75	61.75	–	–	–	–	–	–	–	375.50	4 78	1.90
June 23 to July 2,	127.35	12.74	32.50	32.50	–	32.50	–	–	–	–	–	–	197.00	2 49	1.96

Net Cost of Milk and Manurial Value of Feed.

1. *Juno.*

FEEDING PERIODS.	Total Cost of Feed consumed during Period.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting the Twenty Per Cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
1889 - 1890.					Cents.	Pounds.
Dec. 11 to Dec. 31, .	$5 16	$2 69	$2 15	$3 01	1.48	1,034
Jan. 6 to Feb. 16, .	8 68	5 06	4 05	4 63	1.17	1,045
Feb. 23 to Mar. 13, .	3 53	2 10	1 68	1 85	1.15	1,030
Mar. 18 to Apr. 5, .	3 48	2 16	1 73	1 75	1.13	1,034
Apr. 9 to Apr. 18, .	1 82	1 13	90	92	1.11	1,071
Apr. 25 to May 13, .	5 18	2 57	2 06	3 12	1.64	1,115
May 18 to May 27, .	2 73	1 29	1 03	1 70	1.69	1,095
June 1 to June 19, .	5 00	2 97	2 38	2 62	1.25	1,145
June 23 to July 2, .	2 64	1 62	1 30	1 34	1.26	1,130
Total, . .	$38 22	$21 59	$17 28	$20 94	–	–

2. *Flora.*

Dec. 11 to Dec. 31, .	$5 23	$2 72	$2 18	$3 05	1.68	1,015
Jan. 6 to Feb. 16, .	8 88	5 17	4 14	4 74	1.34	1,004
Feb. 23 to Mar. 13, .	3 27	1 84	1 47	1 80	1.65	960
Mar. 18 to Apr. 5, .	3 45	2 13	1 70	1 75	1.43	980
Apr. 9 to Apr. 18, .	1 79	1 10	88	91	1.25	1,030
Apr. 25 to May 13, .	5 02	2 50	2 00	3 02	2.02	1,050
May 18 to May 27, .	2 66	1 26	1 01	1 65	2.16	1,065
June 1 to June 19, .	4 78	2 84	2 27	2 51	1.67	1,088
June 23 to July 2, .	2 62	1 61	1 29	1 33	1.82	1,085
Total, . .	$37 70	$21 17	$16 94	$20 76	–	–

3. *Jessie.*

Dec. 11 to Dec. 31, .	$5 07	$2 65	$2 12	$2 95	1.79	875
Jan. 6 to Feb. 16, .	8 52	4 96	3 97	4 55	1.51	865
Feb. 23 to Mar. 13, .	3 28	1 85	1 48	1 80	1.57	850
Mar. 18 to Apr. 5, .	3 39	2 06	1 65	1 74	1.39	820
Apr. 9 to Apr. 18, .	1 76	1 07	86	90	1.21	870
Apr. 25 to May 13, .	4 95	2 47	1 98	2 97	2.02	913
May 18 to May 27, .	2 58	1 23	98	1 60	2.14	910
June 1 to June 19, .	4 83	2 87	2 30	2 53	1.62	940
June 23 to July 2, .	2 50	1 54	1 23	1 27	1.57	935
Total, . .	$36 88	$20 70	$16 57	$20 31	–	–

NET COST OF MILK AND MANURIAL VALUE OF FEED — *Concluded.*

4. Roxy.

FEEDING PERIODS.	Total Cost of Feed consumed during Period.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting the Twenty Per Cent taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
1890.					Cents.	Pounds.
Feb. 23 to Mar. 13, .	$3 52	$2 08	$1 66	$1 86	.72	840
Mar. 18 to Apr. 5, .	3 56	2 25	1 80	1 76	.81	853
Apr. 9 to Apr. 18, .	1 86	1 17	94	92	.79	875
Apr. 25 to May 13, .	5 31	1 63	1 30	4 01	1.60	906
May 18 to May 27, .	2 84	1 34	1 07	1 77	1.39	925
June 1 to June 19, .	5 12	3 03	2 42	2 70	1.11	958
June 23 to July 2, .	2 65	1 63	1 30	1 35	1.10	940
Total, . .	$24 86	$13 13	$10 49	$14 37	–	–

5. Pink.

Feb. 23 to Mar. 13, .	$3 09	$1 77	$1 42	$1 67	0.87	773
Mar. 18 to Apr. 5, .	3 54	2 23	1 78	1 76	0.87	820
Apr. 9 to Apr. 18, .	1 79	1 10	88	91	0.85	825
Apr. 25 to May 13, .	5 27	2 61	2 09	3 18	1.48	878
May 18 to May 27, .	2 72	1 29	1 03	1 69	1.53	862
June 1 to June 19, .	4 86	2 89	2 31	2 55	1.11	855
June 23 to July 2, .	2 51	1 55	1 24	1 27	1.14	859
Total, . .	$23 78	$13 44	$10 75	$13 03	–	–

6. Nancy.

Mar. 25 to Apr. 5, .	$2 12	$1 27	$1 02	$1 10	0.72	840
May 18 to May 27, .	2 72	1 29	1 03	1 69	1.30	882
June 1 to June 19, .	4 78	2 84	2 27	2 51	1.00	898
June 23 to July 2, .	2 49	1 54	1 23	1 26	0.99	889
Total, . .	$12 11	$6 93	$5 55	$6 56	–	–

Composition of Fodder Articles fed during the Previously Described Feeding Experiments.

Corn Meal (Average).

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	11.67	233.40	–	–	
Dry matter,	88.33	1,766.60	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,					1 : 9.65
" cellulose,	1.89	37.80	–	–	
" fat,	1.44	28.80	9.79	34	
" protein (nitrogenous matter),	4.44	88.80	67.49	76	
Non-nitrogenous extract matter,	10.46	209.20	177.82	85	
	81.77	1,635.40	1,537.28	94	
	100.00	2,000.00	1,792.38	–	

Wheat Bran (Average).

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	9.27	185.40	–	–	
Dry matter,	90.73	1,814.60	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	7.47	149.40	–	–	1 : 3.94
" cellulose,	9.75	195.00	39.00	20	
" fat,	5.48	109.60	87.68	80	
" protein (nitrogenous matter),	17.53	350.60	308.53	88	
Non-nitrogenous extract matter,	59.77	1,195.40	956.32	80	
	100.00	2,000.00	1,391.53	–	

Composition of Fodder Articles, etc. — Continued.

Old-process Linseed Meal (Average).

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	9.88	197.60	–	–	
Dry matter,	90.12	1,802.40	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	7.39	147.80	–	–	1 : 1.70
" cellulose,	8.74	174.80	45.45	26	
" fat,	7.24	144.80	131.77	91	
" protein (nitrogenous matter),	36.97	739.40	643.28	87	
Non-nitrogenous extract matter,	39.66	793.20	721.81	91	
	100.00	2,000.00	1,542.31	–	

New-process Linseed Meal (Average).

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	5.06	101.20	–	–	
Dry matter,	94.94	1,898.80	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	6.34	126.80	–	–	1 : 1.26
" cellulose,	8.93	178.60	46.44	26	
" fat,	2.17	43.40	39.49	91	
" protein (nitrogenous matter),	41.02	820.40	713.75	87	
Non-nitrogenous extract matter,	41.54	830.80	756.03	91	
	100.00	2,000.00	1,555.71	–	

Composition of Fodder Articles, etc. — Continued.

Hay (Average).

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	9.72	194.40	–	–	
Dry matter,	90.28	1,805.60	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	6.43	128.60	–	–	
" cellulose,	32.28	645 60	374.45	58	1 : 9.68
" fat,	2.49	49.80	22 91	46	
" protein (nitrogenous matter),	9.54	190.80	108.76	57	
Non-nitrogenous extract matter,	49 26	985 20	620.68	63	
	100.00	2,000.00	1,126.80	–	

*Rowen * (Average).*

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	13.53	270.60	–	–	
Dry matter,	86.47	1,729.40	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	6 81	136.20	–	–	
" cellulose,	28.31	566.20	328.40	58	1 : 6.93
" fat,	3.81	76.20	35.05	46	
" protein (nitrogenous matter),	12.94	258.80	147.52	57	
Non-nitrogenous extract matter),	48.13	962.60	606.44	63	
	100.00	2,000.00	1,117.41	–	

* Dried second cut of meadow growth.

Composition of Fodder Articles, etc. — Continued.

Corn Ensilage (Average).

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	72.95	1,459.00	–	–	
Dry matter,	27 05	541.00	–	–	
	100 00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	6 48	129.60	–	–	
" cellulose,	26.33	526.60	379 15	72	1: 11.67
" fat,	5 17	103.40	77.55	75	
" protein (nitrogenous matter),	7.64	152.80	111.54	73	
Non-nitrogenous extract matter,	54.38	1,087.60	728.69	67	
	100 00	2,000.00	1,296.93	–	

Fodder Corn.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	20.42	408 40	–	–	
Dry matter,	79.58	1,591.60	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	7.40	148.00	–	–	
" cellulose,	20 11	402.20	289.58	72	1: 9 80
" fat,	1.65	33.00	24.75	75	
" protein (nitrogenous matter),	8.31	166.20	121.33	73	
Non-nitrogenous extract matter,	62.53	1,250.60	837.90	67	
	100.00	2,000.00	1,273.56	–	

Composition of Fodder Articles, etc. — Continued.

Corn Stover.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	22 50	450.00	–	–	
Dry matter,	77.50	1,550.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	3.97	79.40	–	–	
" cellulose,	34.96	699.20	503.42	72	1 : 8.62
" fat,	1.54	30.80	23.10	75	
" protein (nitrogenous matter),	9.76	195.20	142.50	73	
Non-nitrogenous extract matter,	49.77	995.40	666.92	67	
	100.00	2,000.00	1,335.94	–	

Carrots.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	90.47	1,809.40	–	–	
Dry matter,	9.53	190.60	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	8 67	173.40	–	–	
" cellulose,	8.16	163.20	163.20	100	1 : 9.25
" fat,	1.86	37.20	37.20	100	
" protein (nitrogenous matter),	9.18	183.60	183.60	100	
Non-nitrogenous extract matter,	72.13	1,442.60	1,442.60	100	
	100.00	2,000.00	1,826.60	–	

Composition of Fodder Articles, etc. — Concluded.

Sugar Beets.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	90 02	1,800.40	–	–	
Dry matter,	9.98	199.60	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	11.84	236.80	–	–	
" cellulose,	8.20	164.00	164.00	100	1: 6.74
" fat,	.71	14.20	14.20	100	
" protein (nitrogenous matter),	11.53	230 60	230.60	100	
Non-nitrogenous extract matter,	67.72	1,354.40	1,354.40	100	
	100.00	2,000.00	1,763.20	–	

3. *Summer Feeding Experiments with Milch Cows. July 12 to Sept. 30, 1890.*

Green Crops *vs.* English Hay, first and second cut.
Green feed: vetch and oats, soja beans.
Grain feed: corn meal, wheat bran, new-process linseed meal.

A series of feeding experiments with milch cows have been carried on at the station, since 1887, for the purpose of ascertaining the feeding value of several reputed fodder crops new to our section of the country. The new fodder crops were fed in their green state, and their nutritive value, as well as their general economical merits, compared with those of a good average English hay, first and second cut (rowen). The cutting of the new fodder crops for fodder commenced at the beginning of their blooming, and continued until their maturing. Most of them had at that time some of their seeds matured, yet their stems were still succulent.

The results obtained in this connection in previous years have already been published in our previous annual reports, five, six and seven; they were considered on the whole in a sufficient degree encouraging to advise a continuation of our investigations in that direction. For details regarding the merits of Southern cow-pea, serradella, vetch, vetch and oats and vetch and barley, as substitutes in part or in the whole of an average English hay and rowen, as coarse fodder ingredients of the daily diet in case of the same kinds and the same quantities of grain feed, I have to refer to some of our previous annual reports.

1890. — During our late experiments, July 12 to September 30, we used the following fodder articles in the compounding of the daily diet: a mixed crop of green vetch and oats, or green soja beans, with first and second cut of dried upland meadow growth, English hay and rowen, furnished the coarse feed, while corn meal, wheat bran and new-process linseed meal (Cleveland) served as fine or grain feed. The kind and the quantity of the daily grain feed remained the same during the entire experiment, *i.e.*, corn meal, wheat bran and new-process linseed meal, each three and one-quarter pounds daily per head of cows; five pounds of hay, with all the green crop the cows would consume, finished the daily diet. The green crops were cut into pieces from six to eight inches long before being fed. One-half of the daily ration of grain feed and of green fodder was fed during milking in the morning, and the other half at milking in the evening; the hay was fed between both meals. The daily quantities of grain and of hay remained the same, both being entirely consumed. The daily consumption of the green feed, however, was decided by the appetite of the different cows; vetch and oats varied from fifty to sixty pounds, and soja beans from forty to sixty pounds. The quantity consumed per day decreased in all cases toward the maturing of the crop, on account of the gradual increase of solid matter in the crop. The following statement contains the average daily fodder rations per head; they succeeded each other in the order in which they are reported: —

Daily Fodder Rations used.

I.

Corn meal,	3.25 lbs.
Wheat bran,	3.25 "
New-process linseed meal,	3.25 "
Hay,	5.00 "
Vetch and oats,	54.00 "
Total cost,	22.64 cts.
Net cost,	12.22 "
Manurial value obtainable,	10.42 "
Nutritive ratio,	1:5.97

II.

Corn meal,	3.25 lbs.
Wheat bran,	3.25 "
New-process linseed meal,	3.25 "
Hay,	5.00 "
Soja bean,	55.00 "
Total cost,	27.31 cts.
Net cost,	15.02 "
Manurial value obtainable,	12.29 "
Nutritive ratio,	1:4.69

III.

Corn meal,	3.25 lbs.
Wheat bran,	3.25 "
New-process linseed meal,	3.25 "
Rowen,	20.00 "
Total cost,	26.46 cts.
Net cost,	14.28 "
Manurial value obtainable,	12.18 "
Nutritive ratio,	1:4.92

Price per Ton of the Fodder Articles used in our Valuations.

Corn meal,	$24 00
Wheat bran,	20 00
New-process linseed meal,	26 50
Hay,	15 00
Vetch and oats (green),	2 75
Soja bean (green),	4 40
Rowen (dry second cut of grass),	15 00

The valuation of green vetch and oats and of green soja beans is based on the value adopted for English hay, allowing two tons of English hay or six tons of green grass as the average produce per year for an acre of a good meadow.

The remaining fodder articles were sold at the stated price per ton in our local market of feed stuffs. Some information regarding the raising of vetch and oats and of soja beans will be found farther on in the description of our field experiments.

Valuation of Essential Fertilizing Constituents contained in the Various Fodder Articles used.

Nitrogen, 17 cents per pound; phosphoric acid, 6 cents; potassium oxide, 4½ cents.

	Corn Meal.	Wheat Bran.	New-process Linseed Meal.	Hay.	Vetch and Oats.	Soja Beans.	Rowen.
Moisture at 100° C.,	12.39	11.52	10.06	9.72	76.21	72.95	13.53
Nitrogen, . .	1.466	2.600	5.392	1.379	0.293	0.590	1.790
Phosphoric acid, .	0.707	2.870	1.800	0.352	0.159	0.193	0.464
Potassium oxide, .	0.435	1.620	1.570	1.541	0.566	0.311	1.966
Valuation per 2,000 pounds, . .	$6 22	$13 74	$21 90	$6 50	$1 70	$2 52	$8 42

Six cows, grades, from five to six years old, and in different stages of their milking period, were selected for the experiment. They had been fed, previous to the observation, on a daily ration of corn meal, wheat bran and new-process linseed meal, each 3¼ pounds, with all the rowen called for, — from 20 to 22 pounds per head. Their average daily milk record at that time was as follows: —

1. Jessie, ... from 7.5 to 8 quarts.
2. Roxy, ... from 10 to 11 quarts.
3. Pink, ... from 11 to 12 quarts.
4. Nancy, ... from 11 to 12 quarts.
5. Juno, ... from 9 to 10 quarts.
6. Pearl, ... from 13 to 14 quarts.

The time of observation was subdivided into three periods, which were characterized by the change from vetch and oats to soja beans, and terminating with rowen, as the sole article of coarse food constituents. The grain feed remained the same during the three different feeding periods.

The results of the last experiment lead to similar conclusions as our preceding experiments in 1887, 1888 and 1889, with green vetch, green Southern cow-pea, green serradella and mixed green crops of vetch and oats and vetch and barley. (See Report seven, page 50.)

Conclusions of 1890.

1. The amount of dry matter in the feed consumed during different feeding periods for the production of one quart of milk obtained, varied from 3.32 to 3.55 pounds in case of a daily milk production of from 7 to 8 quarts (Jessie); it varied from 2.62 to 2.99 pounds (Pink), when from 9 to 10 quarts was the daily production of milk; and it was from 1.69 to 1.75 pounds per quart of milk produced when the yield rose to from 13 to 14 quarts (Pearl). The variations in the numerical relation of the amount of dry matter of the feed consumed for the production of one quart of milk, in case of the same animal and the same kind of feed, are materially due to a more or less advanced stage of the milking period of the animal on trial; yet they rarely correspond in different animals. Constitutional differences quite frequently modify the results under otherwise corresponding conditions.

2. The total cost of the feed consumed in connection with the production of one quart of milk differed during the same feeding period, in case of different animals, from 1.69 cents to 3.43 cents; 1.69 cents in case of Pearl and 3.43 cents in case of Jessie, second feeding period, — soja beans. This difference is mainly due to the rate of the daily yield of milk; yet constitutional peculiarities sometimes affect materially the final results.

3. The net cost of the feed consumed for the production of one quart of milk varied in case of different cows from 0.93 cents to 1.88 cents; Pearl 0.93 cents and Jessie 1.88 cents, second period, — soja-bean ration.

4. The market value of the obtainable manurial refuse amounts per quart of milk produced on an average to more than three-sevenths part of the entire cost of the daily fodder ration. Net cost of feed represents the money value of the feed after 80 per cent. of the manurial value of the

phosphoric acid, potassium oxide and nitrogen it contains has been deducted.

5. The soja bean exceeds in our case in five out of six cases the vetch and oats in feeding effect. Vetch and oats compare well with a good rowen. The latter leads the English hay thus far in all our observations with milk production.

6. Judging from our own experience, we can only recommend very highly the practice of raising any of the stated new fodder crops, after due consideration of local circumstances, either alone or as mixed crops, for the purpose of increasing the fodder resources of the farm during summer and autumn. They may serve as green fodder as well as hay; most of them have a higher nutritive ratio than either English hay, corn fodder or corn stover: they tend to improve the soil chemically and physically; they yield liberal returns, and are, as a rule, highly relished by cattle.

FEEDING RECORD.

JESSIE: *Age, six years; grade, Jersey; last calf, Jan. 12, 1889.*

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.							Amount of Dry Vegetable Matter contained in the Daily Fodder consumed (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Period (Pounds).
	Corn Meal.	Wheat Bran.	New-process Linseed Meal.	Hay.	Vetch and Oats.	Soja Bean.	Rowen.					
1890.												
July 12 to Aug. 1, ...	3.25	3.25	3.25	4.38	50.10	–	–	24.52	7.23	3.39	1 : 5.82	901
Aug. 12 to Sept. 1, ...	3.25	3.25	3.25	5.00	–	57.67	–	28.76	8.11	3.55	1 : 4.70	908
Sept. 10 to Sept. 30, ...	3.25	3.25	3.25	–	–	–	19.24	25.29	7.60	3.33	1 : 4.89	924
ROXY: *Age, seven years; grade, Ayrshire; last calf, Feb. 5, 1890.*												
July 12 to Aug. 1, ...	3.25	3.25	3.25	5.00	59.14	–	–	27.23	10.13	2.69	1 : 6.10	950
Aug. 12 to Sept. 1, ...	3.25	3.25	3.25	5.00	–	60.29	–	29.47	9.97	2.96	1 : 4.72	954
Sept. 10 to Sept. 30, ...	3.25	3.25	3.25	–	–	–	20.95	26.77	8.03	3.33	1 : 4.96	1,000
PINK: *Age, six years; native; last calf, Jan. 23, 1890.*												
July 12 to Aug. 1, ...	3.25	3.25	3.25	5.00	55.67	–	–	26 40	10.06	2 62	1 : 6.01	851
Aug. 12 to Sept. 1, ...	3.25	3.25	3.25	5.00	–	61.19	–	29.71	10.96	2 71	1 : 4.73	876
Sept. 10 to Sept. 30, ...	3.25	3.25	3.25	–	–	–	20.00	25.94	8.68	2.99	1 : 4.92	873

FEEDING RECORD — *Concluded.*

NANCY: *Age, seven years; native; last calf, March 16, 1890.*

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.							Amount of Dry Vegetable Matter contained in the Daily Fodder consumed (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Period (Pounds).
	Corn Meal.	Wheat Bran.	New-process Linseed Meal.	Hay.	Vetch and Oats.	Soja Bean.	Rowen.					
1890.												
July 12 to Aug. 1,	3.25	3.25	3.25	4 81	52.48	–	–	25 47	11.23	2.27	1 : 5.92	877
Aug. 12 to Sept. 1,	3.25	3.25	3.25	5 00	–	54 33	–	27.86	11.42	2.44	1 : 4.69	868
Sept. 10 to Sept. 30,	3.25	3.25	3.25	–	–	–	19.57	25.57	10.61	2.41	1 : 4.90	893
JUNO: *Age, seven years; grade, Ayrshire; last calf, June 22, 1889.*												
July 12 to Aug. 1,	3.25	3 25	3.25	4.71	51.33	–	–	25.11	9.09	2.76	1 : 5.88	1,097
Aug. 12 to Sept. 1,	3 25	3.25	3 25	5.00	–	55.19	–	28.09	8.67	3.24	1 : 4.69	1,104
Sept. 10 to Sept. 30,	3.25	3.25	3.25	–	–	–	20.90	26.72	8.16	3.27	1 : 4.96	1,139
PEARL: *Age, five years; native; last calf, Aug. 8, 1890.*												
Aug. 19 to Sept. 4,	3.25	3 25	3.25	5.00	–	40.88	–	24.22	14.32	1.69	1 : 4.60	777
Sept. 10 to Sept. 30,	3.25	3 25	3 25	–	–	–	18.52	24.66	13.30	1.85	1 : 4.85	796

Total Cost of Feed per Quart of Milk.

Jessie.

FEEDING PERIODS.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of New-process Linseed Meal consumed (Pounds.)	Total Amount of Hay consumed (Pounds).	Total Amount of Vetch and Oats consumed (Pounds).	Total Amount of Soja Bean consumed (Pounds).	Total Amount of Rowen consumed.	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
1890.											
July 12 to Aug. 1, ...	151.86	7.23	68.25	68.25	68.25	92.00	1,052.00	–	–	$4 54	2.99
Aug. 12 to Sept. 1, ...	170 35	8 11	68.25	68.25	68.25	105.00	–	1,211,00	–	5 85	3.43
Sept. 10 to Sept. 30, ...	159.65	7.60	68.25	68.25	68.25	–	–	–	404.00	5 43	3.40
Roxy.											
July 12 to Aug. 1, ...	212.79	10.13	68.25	68.25	68.25	105.00	1,242.00	–	–	$4 90	2.30
Aug. 12 to Sept. 1, ...	209.42	9.97	68.25	68.25	68.25	105.00	–	1,266.00	–	5 98	2.86
Sept. 10 to Sept. 30, ...	168.72	8.03	68.25	68.25	68.25	–	–	–	440.00	5 70	3.38
Pink.											
July 12 to Aug. 1, ...	211.28	10.06	68.25	68.25	68.25	105.00	1,169.00	–	–	$4 80	2.27
Aug. 12 to Sept. 1, ...	230.12	10.96	68 25	68.25	68.25	105.00	–	1,285.00	–	6 02	2 62
Sept. 10 to Sept. 30, ...	182.33	8.68	68.25	68.25	68.25	–	–	–	420.00	5 55	3.04

TOTAL COST OF FEED PER QUART OF MILK — *Concluded.*

Nancy.

FEEDING PERIODS.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of New-process Linseed Meal consumed (Pounds).	Total Amount of Hay consumed (Pounds).	Total Amount of Vetch and Oats consumed (Pounds).	Total Amount of Soja Bean consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
1890.											
July 12 to Aug. 1, ...	235.93	11 23	68.25	68.25	68.25	101.00	1,102.00	–	–	$4 68	1.98
Aug. 12 to Sept. 1, ...	239.77	11.42	68.25	68.25	68.25	105.00	–	1,141.00	–	5 70	2.38
Sept. 10 to Sept. 30, ...	222.79	10.61	68.25	68.25	68.25	–	–	–	411.00	5 48	2.46
Juno.											
July 12 to Aug. 1, ...	190.96	9.09	68.25	68.25	68.25	99.00	1,078.00	–	–	$4 63	2.42
Aug. 12 to Sept. 1, ...	182.09	8.67	68.25	68.25	68.25	105.00	–	1,159.00	–	5 74	3.15
Sept. 10 to Sept. 30, ...	171.40	8.16	68.25	68.25	68.25	–	–	–	439.00	5 69	3.32
Pearl.											
Aug. 19 to Sept. 4, ...	243.37	14.32	55 25	55.25	55.25	85.00	–	695.00	–	$4 11	1 69
Sept. 10 to Sept. 30, ...	279.30	13.30	68.25	68.25	68.25	–	–	–	389.00	5 32	1.90

Net Cost of Milk and Manurial Value of Feed.

Jessie.

FEEDING PERIODS.	Total Cost of Feed consumed during Period.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting Twenty Per Cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
1890.					Cents.	Pounds.
July 12 to Aug. 1, .	$4 54	$2 62	$2 10	$2 44	1.61	900
Aug. 12 to Sept. 1, .	5 85	3 30	2 64	3 21	1.88	900
Sept. 10 to Sept. 30, .	5 43	3 13	3 50	2 93	1.84	940
Total, . . .	$15 82	$9 05	$7 24	$8 58	–	–

Roxy.

July 12 to Aug. 1, .	$4 90	$2 83	$2 26	$2 64	1.24	960
Aug. 12 to Sept. 1, .	5 98	3 37	2 70	3 28	1 57	945
Sept. 10 to Sept. 30, .	5 70	3 28	2 62	3 08	1 83	1,013
Total, . .	$16 58	$9 48	$7 58	$9 00	–	–

Pink.

July 12 to Aug. 1, .	$4 80	$2 76	$2 21	$2 59	1.23	865
Aug. 12 to Sept. 1, .	6 02	3 39	2 71	3 31	1.44	880
Sept. 10 to Sept. 30, .	5 55	3 20	2 56	2 99	1 64	874
Total, . .	$16 37	$9 35	$7 48	$8 89	–	–

Nancy.

July 12 to Aug. 1, .	$4 68	$2 70	$2 16	$2 52	1.07	880
Aug 12 to Sept. 1, .	5 70	3 21	2 57	3 13	1.31	870
Sept. 10 to Sept. 30, .	5 48	3 16	2 53	2 95	1.32	905
Total, . .	$15 86	$9 07	$7 26	$8 60	–	–

NET COST OF MILK AND MANURIAL VALUE OF FEED — *Concluded.*

Juno.

FEEDING PERIODS.	Total Cost of Feed consumed during Period.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting Twenty Per Cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
1890.					Cents.	Pounds.
July 12 to Aug. 1, .	$4 63	$2 67	$2 14	$2 49	1.30	1,105
Aug. 12 to Sept. 1, .	5 74	3 23	2 58	3 16	1.74	1,105
Sept. 10 to Sept. 30, .	5 69	3 28	2 62	3 07	1.79	1,160
Total, . .	$16 06	$9 18	$7 34	$8 72	–	–

Pearl.

Aug. 19 to Sept. 4, .	$4 11	$2 31	$1 85	$2 26	0 93	772
Sept. 10 to Sept. 30, .	5 32	3 07	2 45	2 87	1.03	810
Total, . .	$9 43	$5 38	$4 30	$5 13	–	–

ANALYSES OF MILK.

Jessie.

	July 15.	July 22.	July 29.	Aug. 19.	Aug. 26.	Sept. 16.	Sept. 23.	Sept. 30.
Solids, . .	16.23	15.57	15.31	16.36	14.92	14.18	14.51	14.20
Fat, . . .	6.87	6.09	6.07	6.18	5.87	5.38	5.35	5.33
Solids not fat, .	9.36	9.48	9.24	10.18	9.05	8.80	9.16	8.87

Roxy.

Solids, . .	13.45	13.37	13.00	14.72	14.00	12.43	13.82	14.18
Fat, . . .	4.17	4.03	2.63	4.87	4.29	3.32	4.52	4.71
Solids not fat, .	9.28	9.34	10.37	9.85	9.71	9.11	9.30	9.47

ANALYSES OF MILK — *Concluded.*

Pink.

	July 15.	July 22.	July 29.	Aug. 19.	Aug. 26.	Sept. 16.	Sept. 23.	Sept. 30.
Solids, . .	15.15	15.26	14.57	15.03	15.57	14 59	15 22	14.82
Fat, . . .	5.19	5.60	5.12	5.17	5.68	5.37	5 89	5.28
Solids not fat, .	9.96	9.66	9.45	9.86	9.89	9.22	9.33	9.54

Nancy.

Solids, . .	13.21	13.29	13.31	13.92	14.18	12 54	13.85	12.61
Fat, . . .	4.22	4 02	4.18	4.56	4.48	4.02	5.14	4.03
Solids not fat, .	8.99	9 27	9.13	9.36	9.70	8.52	8.71	8.58

Juno.

Solids, . .	13.84	13.56	13.94	14 48	14 58	13 39	13.71	13.62
Fat, . . .	4.70	4.13	4.51	4 63	4.73	4.66	4.81	4.53
Solids not fat, .	9.14	9.43	9.43	9.85	9.85	8 73	8.90	9.09

Pearl.

Solids, . .	–	–	–	14 22	13 78	11 36	11.99	11.52
Fat, . . .	–	–	–	4 48	4 45	2 98	3.62	3.23
Solids not fat, .	–	–	–	9.74	9.33	8.38	8.37	8.29

COMPOSITION OF FODDER ARTICLES FED DURING THE PREVIOUSLY DESCRIBED EXPERIMENT.

Corn Meal (Average).

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	12.39	247.80	–	–	
Dry matter,	87.61	1,752.20	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	1.80	36.00	–	–	
" cellulose,	1.80	36.00	12.24	34	1 : 9.70
" fat,	5.01	100.20	76.15	76	
" protein (nitrogenous matter),	10.46	209.20	177.82	85	
Non-nitrogenous extract matter,	80.93	1,618.60	1,521.48	94	
	100.00	2,000.00	1,787.69	–	

New-process Linseed Meal.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	10.06	201.20	–	–	
Dry matter,	89.94	1,798.80	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	6.17	123.40	–	–	
" cellulose,	9.22	184.40	47.94	26	1 : 1.54
" fat,	3.61	72.20	65.70	91	
" protein (nitrogenous matter),	37.47	749.40	651.98	87	
Non-nitrogenous extract matter,	43.53	870.60	792.25	91	
	100.00	2,000.00	1,557.87	–	

COMPOSITION OF FODDER ARTICLES, ETC. — *Continued.*

Wheat Bran.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	11.52	230.40	–	–	
Dry matter,	88.48	1,769.60	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	7.13	142.60	–	–	
" cellulose,	10.63	212.60	42.52	20	
" fat,	5.62	112.40	89.92	80	
" protein (nitrogenous matter),	18.36	367.20	323.14	88	1 : 3.71
Non-nitrogenous extract matter,	58.26	1,165.20	932.16	80	
	100.00	2,000 00	1,387.74	–	

Vetch and Oats.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	76.21	1,524.20	–	–	
Dry matter,	23.79	475.80	–	–	
	100.00	2,000 00	–	–	
Analysis of Dry Matter.					
Crude ash,	7.25	145.00	–	–	
" cellulose,	31.73	634.60	–	–	
" fat,	3.37	67.40	33.70	50	
" protein (nitrogenous matter),	7.70	154.00	92.40	60	1 : 11.72
Non-nitrogenous extract matter,	49.95	999.00	999.00	100	
	100.00	2,000.00	1,125.10	–	

COMPOSITION OF FODDER ARTICLES, ETC. — *Concluded.*

Soja Beans.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	72.95	1,459.00	–	–	
Dry matter,	27.05	541.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	11.05	221.00	–	–	
" cellulose,	24.73	494.60	355.12	71.8	1 : 5.43
" fat,	7.22	144.40	26.28	18.2	
" protein (nitrogenous matter),	13.64	272.80	174.59	64	
Non-nitrogenous extract matter,	43.36	867.20	527.26	60.8	
	100.00	2,000 00	1,083.25	–	

For analysis of English hay, see preceding feeding records for 1889–90.

4. *Creamery Record of the Station for the Years 1889 and 1890.*

The cost of feed consumed is based on the market price of the various ingredients, as is stated in the subsequent table.

The valuation of the whole milk is taken at three cents per quart. The estimates of the value of fertilizing ingredients contained in the feed are also based on those given in the following table : —

Local Market Value per Ton of the Various Articles of Fodder used.

Corn meal,	$23 00
Corn and cob meal,	20 70
Wheat bran,	21 50
Rye middlings,	21 50
Gluten meal,	23 00
New-process linseed meal,	26 00
Old-process linseed meal,	27 00

Local Market Value per Ton, etc. — Concluded.

Hay,	$15 00	Soja bean (green),	$4 40
Rowen,	15 00	Vetch and oats (green),	2 75
Corn fodder,	5 00	Vetch (green),	3 50
Corn stover,	5 00	Serradella (green),	3 16
Corn ensilage,	2 25	Cow-pea (green),	3 14
Millet (dry),	12 00	Barley and horse bean (green),	3 00
Lucerne and vetch (dry),	12 00	Potatoes,	6 67
Lucerne and clover (dry),	12 00	Carrots,	7 00
Oats (dry),	12 00	Sugar beets,	5 00
Oats (green),	3 60		

Valuation of the Essential Fertilizing Constituents contained in the Various Articles of Fodder used.

Nitrogen, 16½ cents per pound; phosphoric acid, 6 cents; potassium oxide, 4½ cents.

[Per cent.]

	Nitrogen.	Phosphoric Acid.	Potassium Oxide.	Valuation per Ton.
Corn meal,	1.86	0.77	0.45	$7 44
Corn and cob meal,	1.46	0.603	0.441	5 91
Wheat bran,	2.82	3.05	1.49	14 24
Rye middlings,	1.84	1.26	0.81	8 27
Gluten meal,	5.22	0.40	0.05	17 75
New-process linseed meal,	6.25	1.42	1.16	23 32
Old-process linseed meal,	5.33	1.64	1.16	20 54
Hay,	1.25	0.464	2.085	6 46
Rowen,	1.93	0.364	2.86	9 24
Corn fodder (dry),	1.37	0.368	0.355	5 26
Corn stover (dry),	0.78	0.09	0.599	3 19
Corn ensilage,	0.36	0.14	0.33	1 64
Millet (dry),	1.106	0.38	2.49	6 23
Lucerne and vetch (dry),	2.02	0.70	2.273	9 44
Lucerne and clover (dry),	2.06	0.623	1 805	9 08
Oats (dry),	1.47	0.51	2.41	7 51
Oats (green),	0.33	0.155	0.68	1 85

Valuation of Essential Fertilizing Constituents, etc. — Concluded.

	Nitrogen.	Phosphoric Acid.	Potassium Oxide.	Valuation per Ton.
Soja bean (green), . . .	0.590	0.193	0.311	$2 44
Vetch and oats (green), . .	0.23	0.09	0.79	1 54
Vetch (green), ...	0.49	0.20	0.66	2 42
Serradella (green), . . .	0.411	0.14	0.423	1 89
Cow-pea (green), ...	0.561	0.098	0.306	2 23
Barley and beans (green), . .	0 50	0.20	0.40	2 23
Potatoes, ...	0.476	0.18	0.56	2 18
Carrots, ...	0.14	0.10	0.54	1 04
Sugar beets, ...	0.29	0.03	0.18	1 15

The value of cream is that granted us from month to month by our local creamery association. The station has no other connection with the financial management of the creamery.

Our presentation of financial results is based on the local cost of feed alone, and does not consider interest on investment and labor involved; for the reason that approximate estimates on these points are in an exceptional degree dependent on quality of stock, and varying local circumstances. The details are embodied in a few subsequent tables under the following headings: —

1. Statement of articles of fodder used.
2. Record of average quality of milk and of fodder rations.
3. Value of cream produced at creamery basis of valuation.
4. Cost of skim-milk at the selling price of three cents per quart of whole milk.
5. Fertilizing constituents of cream.
6. Some conclusions suggested by the records.
7. Analyses of cream, and modes of analysis of milk, cream and butter.

1. Statement of Articles of Fodder used during 1889 (in Pounds).

	Corn Meal.	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	Hay.	Rowen.	Fodder Corn.	Corn Stover.	Corn Ensilage.	Vetch and Oats.	Serradella.	Cow-pea.	Carrots.	Sugar Beets.
January, . .	608.75	604.75	584.75	–	1,772.00	–	–	–	1,475.00	–	–	–	4,868.00	–
February, . .	552.50	552.50	552.50	–	1,268.50	–	–	–	5,069.50	–	–	–	–	–
March, . .	591.50	591.50	591.50	–	2,396.00	–	–	–	–	–	–	–	–	4,084.00
April, . . .	572.00	562.25	563.88	–	2,395.50	838.00	–	–	–	–	–	–	–	1,125.00
May, . . .	604.50	583.38	604.50	–	900.50	2,713.50	–	–	–	–	–	–	–	–
June, . . .	585.00	585.00	585.00	–	1,858.50	1,295.50	–	–	–	582.75	–	–	–	–
July, . . .	604.50	604.50	604.50	–	434.00	1,871.00	–	–	–	4,308.75	–	–	–	–
August, . .	402.00	402.00	402.00	–	180.00	3,755.25	–	–	–	–	–	1,512.00	–	–
September, . .	585.00	585.00	585.00	–	1,002.00	–	–	–	–	–	8,182.50	4,983.00	–	–
October, . .	604.50	604.50	604.50	–	3,574.50	–	–	–	–	–	–	–	–	–
November, . .	585.00	585.00	585.00	–	3,491.50	–	–	–	–	–	–	–	–	–
December, . .	604.50	604.50	88.00	516.50	3,451.00	–	–	–	–	–	–	–	–	–

1. Statement of Articles of Fodder used during 1890 (in Pounds).

	Corn Meal.	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	New-process Linseed Meal.	Cotton-seed Meal.	Hay.	Rowen.	Fodder Corn.	Corn Stover.	Corn Ensilage.	Vetch and Oats.	Soja Beans.	Carrots.	Sugar Beets.
January, .	604.50	604.50	–	604.50	–	–	1,016.00	–	–	–	7,737.50	–	–	–	–
February, .	370.50	546.00	–	529.75	–	–	514.00	–	850.50	–	4,687.50	–	–	1,080.00	–
March, .	–	604.50	–	604.50	–	–	–	–	1,132.00	1,665.00	–	–	–	3,680.00	–
April, . .	184.50	577.50	–	106.50	444.00	–	977.00	–	1,201.50	472.50	–	–	–	2,520.00	1,080.00
May, . .	604.50	604.50	–	340.50	262.50	–	2,656.50	360.00	–	–	–	–	–	–	3,240.00
June, . .	585.00	585.00	–	379 50	204.00	–	–	3,723.50	–	–	–	–	–	–	–
July, . .	604.50	604.50	–	–	604.50	–	725.50	613.00	–	–	–	7,463.00	–	–	–
August, .	604.50	604.50	–	–	604.50	–	920.00	–	–	–	–	910 50	8,882.50	–	–
September, .	585.00	585.00	–	–	585.00	–	120.00	2,935.00	–	–	–	–	1,767.00	–	–
October, .	571.50	571.50	–	–	223.50	348.00	–	3,221.50	–	–	–	–	–	–	–

2. *Record of Average Quality of Milk and of Fodder Rations (1889).*

1889.	Average Percentage of Solids in Milk.	Average Percentage of Fat in Milk.	Quarts of Milk required to make One Space of Cream.	Nutritive Ratio of Feed.	Feed consumed per Day (in Pounds).													
					Corn Meal.	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	Hay.	Rowen.	Fodder Corn.	Corn Ensilage.	Carrots.	Sugar Beets.	Vetch and Oats.	Serradella.	Cow-pea.
January,	14.49	3.90	1.76	1 : 6.21	3.25	3.25	3.25	–	10.00	–	–	–	39.57	–	–	–	–
February,	13.93	4.29	1.74	1 : 6.57	3.25	3.25	3.25	–	5.00	–	–	36.51	–	–	–	–	–
March,	14.12	4.36	1.65	1 : 5.99	3.25	3.25	3.25	–	16.40	–	–	–	–	–	–	–	–
				1 : 6.14	3.25	3.25	3.25	–	10.00	–	–	–	–	45.60	–	–	–
April,	14.14	4.56	1.62	1 : 6.12	3.25	3.25	3.25	–	18.38	–	–	–	–	–	–	–	–
May,	14.03	4.34	1.60	1 : 5.21	3.25	3.25	3.25	–	–	19.53	–	–	–	–	–	–	–
June,	14.42	4.58	1.62	1 : 5.30	3.25	3.25	3.25	–	–	20.60	–	–	–	–	–	–	–
				1 : 6.18	3.25	3.25	3.25	–	18.00	–	–	–	–	–	–	–	–
July,	13.92	4.30	1.72	1 : 6.38	3.25	3.25	3.25	–	5.00	–	–	–	–	–	46.50	–	–
				1 : 5.30	3.25	3.25	3.25	–	–	20.60	–	–	–	–	–	–	–
August,	13.85	4.21	1.70	1 : 5.62	3.25	3.25	3.25	–	–	24.10	–	–	–	–	–	–	–
September,	13.82	4.48	1.65	1 : 6.05	3.25	3.25	3.25	–	5.00	–	–	–	–	–	–	–	76.23
				1 : 4.70	3.25	3.25	3.25	–	5.00	–	–	–	–	–	–	78.23	–
October,	14.34	4.72	1.53	1 : 6.26	3.25	3.25	3.25	–	19.30	–	–	–	–	–	–	–	–
November,	–	–	1.53	1 : 6.26	3.25	3.25	3.25	–	19.40	–	–	–	–	–	–	–	–
December,	14.33	4.64	1.44	1 : 5.72	3.25	3.25	–	3.25	18.44	–	–	–	–	–	–	–	–
Averages,	14.12	4.39	1.63	1 : 5.88													

2. *Record of Average Quality of Milk and of Fodder Rations (1890).*

1890.	Average Percentage of Solids in Milk.	Average Percentage of Fat in Milk.	Quarts of Milk required to make one Space of Cream.	Nutritive Ratio of Feed.	Feed consumed per Day (in Pounds).															
					Corn Meal.	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	New-process Linseed Meal.	Cotton-seed Meal.	Hay.	Rowen.	Fodder Corn.	Corn Stover.	Corn Ensilage.	Vetch and Oats.	Soja Bean.	Carrots.	Sugar Beets.
January, .	14.18	4.72	1.45	1 : 6.25	3.25	3.25	–	3.25	–	–	5.00	–	–	–	44.74	–	–	–	–
February, .	14.02	4.64	1.51	1 : 6.25	3.25	3.25	–	3.25	–	–	5.00	–	–	–	44.74	–	–	–	–
				1 : 5.14	–	3.25	–	3.25	–	–	–	–	13.74	–	–	–	–	20.00	–
March, .	14.21	4.99	1.57	1 : 5.14	–	3.25	–	3.25	–	–	–	–	13.74	–	–	–	–	20.00	–
				1 : 5.14	–	3.25	–	3.25	–	–	–	–	–	16.00	–	–	–	20.00	–
April, .	13.37	4.42	1.66	1 : 4.95	–	3.25	–	–	3.25	–	–	–	16.13	–	–	–	–	20.00	–
				1 : 5.22	3.25	3.25	–	–	3.25	–	15.90	–	–	–	–	–	–	–	20.00
May, . .	13.73	4.38	1.75	1 : 5.22	3.25	3.25	–	–	3.25	–	15.90	–	–	–	–	–	–	–	20.00
				1 : 5.60	3.25	3.25	–	3.25	–	–	15.67	–	–	–	–	–	–	–	20.00
June, . .	13.42	4.39	1.76	1 : 5.04	3.25	3.25	–	3.25	–	–	–	20.60	–	–	–	–	–	–	–
				1 : 4.73	3.25	3.25	–	–	3.25	–	–	20.75	–	–	–	–	–	–	–
July, . .	13.91	4.45	1.67	1 : 5.96	3.25	3.25	–	–	3.25	–	5.00	–	–	–	–	53.75	–	–	–
August, .	14.65	4.95	1.61	1 : 4.69	3.25	3.25	–	–	3.25	–	5.00	–	–	–	–	–	55.00	–	–
September,	13.47	4.57	1.59	1 : 4.91	3.25	3.25	–	–	3.25	–	–	19.86	–	–	–	–	–	–	–
October, .	13.84	4.82	1.56	1 : 4.91	3.25	3.25	–	–	3.25	–	–	19.86	–	–	–	–	–	–	–
				1 : 4.84	3.00	3.00	–	–	–	3.00	–	19.25	–	–	–	–	–	–	–
Averages,	13.88	4.63	1.61	1 : 5.25															

3. Value of Cream produced at Creamery Basis of Valuation.

	Total Cost of Feed consumed.	Total Value of Fertilizing Constituents of Food consumed.	Value of Fertilizing Constituents lost in Cream.	Net Cost of Feed for Production of Cream.	Value of Cream produced.
1889.					
January,	$52 21	$21 23	$0 66	$31 64	$40 60
February,	33 86	19 15	0 63	15 34	36 19
March,	48 14	21 77	0 75	27 11	42 48
April,	46 17	23 40	0 78	23 55	42 84
May,	47 28	27 23	0 83	20 88	39 28
June,	44 21	23 98	0 72	20 95	33 06
July,	43 63	25 28	0 76	19 11	34 92
August,	45 44	27 54	0 76	18 66	36 33
September,	48 01	28 08	0 73	20 66	38 25
October,	47 21	23 47	0 71	24 45	39 06
November,	45 93	22 82	0 66	23 77	36 11
December,	47 18	24 38	0 67	23 47	36 68
Averages,	$45 77	$24 03	$0 72	$22 46	$37 98
1890.					
January,	$37 78	$23 07	$0 64	$15 35	$33 99
February,	32 19	19 62	0 69	13 26	36 93
March,	34 38	19 75	0 66	15 29	37 52
April,	38 54	19 75	0 68	19 47	32 40
May,	52 09	25 32	0 73	27 50	33 45
June,	48 63	30 05	0 72	19 30	30 66
July,	41 65	23 90	0 68	18 43	29 04
August,	49 09	27 52	0 73	22 30	39 27
September,	47 43	28 63	0 72	19 47	42 05
October,	44 48	27 82	0 65	17 31	39 92
Averages,	$42 63	$24 55	$0 69	$18 77	$35 52

4. Cost of Skim-milk at the Selling Price of Three Cents per Quart for Whole Milk.

	Quarts of Milk produced.	Spaces of Cream.	Quarts of Cream (One Quart equals 3.4 Spaces).	Quarts of Skim-milk.	Value of Cream per Space (Cents).	Value of Cream per Quart of Milk (Cents).	Total Value of Cream.	Cost of Skim-milk per Quart (Whole Milk at Three Cents per Quart).	Total Cost of Skim-milk.
1889.								Cents.	
January, .	1,791.1	1,015	298.5	1,492.6	4.00	2.27	$40 60	0.88	$13 13
February, .	1,680.0	965	283.8	1,396.2	3.75	2.15	36 19	1.02	14 21
March, . .	1,895.0	1,148	337.6	1,557.4	3.70	2.24	42 48	0.92	14 37
April, . .	1,931.6	1,190	350.0	1,581.6	3.60	2.22	42 84	0.96	15 11
May, . .	2,025.2	1,267	372.6	1,652.6	3.10	1.94	39 28	1.30	21 48
June, . .	1,785.6	1,102	324.1	1,461.5	3.00	1.85	33 06	1.40	20 51
July, . .	2,001.2	1,164	342.4	1,658.8	3.00	1.74	34 92	1.51	25 12
August, . .	1,991.9	1,172	344.7	1,647.2	3.10	1.82	36 33	1.42	23 43
September, .	1,856.0	1,125	330.9	1,525.1	3.40	2.06	38 25	1.14	17 43
October, .	1,665.0	1,085	319.1	1,345.9	3.60	2.35	39 06	0.81	10 89
November, .	1,538.1	1,003	295.0	1,243.1	3.60	2.35	36 11	0.81	10 03
December, .	1,463.8	1,019	299.7	1,164.1	3.60	2.51	36 68	0.62	7 23
Averages, .	1,802.0	1,105	324.9	1,477.2	3.45	2.13	$37 98	1.07	$16 08
1890.									
January, .	1,404.1	971	285.6	1,118.5	3.50	2.42	$33 99	0.73	$8 13
February, .	1,596.2	1,055	310.3	1,285.9	3.50	2.31	36 93	0.85	10 96
March, . .	1,594.8	1,014	298.2	1,296.6	3.70	2.35	37 52	0.80	10 32
April, . .	1,720.8	1,035	304.4	1,416.4	3.13	1.88	32 40	1.36	19 22
May, . .	1,946.7	1,115	327.9	1,618.8	3.00	1.72	33 45	1.54	24 95
June, . .	1,922.4	1,095	322.1	1,600.3	2.80	1.59	30 66	1.69	27 01
July, . .	1,727.0	1,037	305.0	1,422.0	2.80	1.68	29 04	1.60	22 77
August, . .	1,809.5	1,122	330.0	1,479.5	3.50	2.17	39 27	1.02	15 02
September, .	1,747.4	1,098	322.9	1,424.5	3.83	2.41	42 05	0.73	10 37
October, .	1,556.9	998	293.5	1,263.4	4.00	2.56	39 92	0.54	6 79
Averages, .	1,702.6	1,054	310.0	1,392.6	3.38	2.11	$35 52	1.09	$15 55

5. Fertilizing Constituents of Cream.

[Average analysis.]

	Per Cent.
Moisture at 100° C., ...	75.22
Nitrogen (16½ cents per pound), ...	.54
Potassium oxide (4¼ cents per pound), ...	.123
Phosphoric acid (6 cents per pound), ...	.168

6. Conclusions.

1. The nutritive ratio of the feed in 1889 varied from 1 : 4.70 to 1 : 6.57, with an average of 1 : 5.88 ; it varied in 1890 from 1 : 4.64 to 1 : 6.25, with an average of 1 : 5.25.

2. The amount of fat in the milk varied, during the year 1889, from 3.90 per cent. to 4.72 per cent., average 4.39 per cent. In 1890 it varied from 4.38 per cent. to 4.99 per cent , with an average of 4.63 per cent.

3. The total solids varied, in 1889, from 13.82 per cent. to 14.49 per cent., average 14.12 per cent. In 1890 it ran from 13.37 per cent. to 14.65 per cent., average 13.88 per cent.

4. Total cost of feed for one quart of cream amounts, in 1889, to 14.09 cents, and in 1890 to 13.75 cents.

5. Net cost of feed for one quart of cream amounts, in 1889, to 6.09 cents, and in 1890 to 6.05 cents.

6. The value received for one space of cream varied, in 1889, from 3 to 4 cents, with an average of 3.43 cents. In 1890 it varied from 2.80 to 4 cents, with an average of 3.38 cents, which amounts, per quart, in 1889 to 11.69 cents, and in 1890 to 11.46 cents.

7. The quantity of milk, in quarts, required to produce one space of cream, in 1889, amounted to 1.63, and 1.62 in 1890, or 5.54 quarts of whole milk to produce one quart of cream in 1889, and 5.49 quarts in 1890.

8. The net cost of feed per quart of cream averages, in 1889, 6.9 cents, and in 1890 6.05 cents. We received per quart of cream, in 1889, 11.69 cents, and in 1890 11.46 cents, thereby securing a profit of 4.79 cents in 1889, and 5.41 cents in 1890.

From these statements it appears, as has already been claimed in previous reports, that close fodder rations tend to improve the quality of the milk, as well as the condition of the animal.

For further details concerning results in preceding years, see pages 82 to 84, seventh annual report.

Our average statements for the current year apply in each case to only ten months, due to the fact that financial settlement with our local creamery is made two months after cream is furnished.

7. *Creamery Record, 1890. — Analyses of Cream and Butter Fat.*

Date of Sampling.	Analysis of Cream.			Date of Testing.	Analysis of Fat.		Average Daily Fodder Ration.
	Solids.	Fat.	Solids not Fat.		Volatile Acids.	Non-volatile Acids.	
1890.				**1890.**			
January 23,	27.62	18.65	8.97	January 23,	6.55	86.93	3¼ pounds corn meal, 3¼ pounds wheat bran, 3¼ pounds old-process linseed meal, 5 pounds hay, 50 pounds corn ensilage.
" 24,	27.85	17.80	10.05	" 24,	6.63	87.10	
" 27,	25.08	17.30	7.68	" 27,	6.29	87.99	
February 3,	27.52	19.20	8.32	February 3,	6.61	88.92	
" 5,	25.80	18.31	7.49	" 5,	6.53	88.18	
" 11,	27.70	18.43	9.27	" 11,	6.40	88.60	
February 24,	26.47	20.96	5.51	February 24,	6.12	89.20	3¼ pounds wheat bran, 3¼ pounds old-process linseed meal, 20 pounds carrots, 18 pounds fodder corn.
" 26,	25.18	16.52	8.66	" 26,	6.37	89.02	
March 3,	25.10	16.62	8.48	March 3,	6.44	88.84	
" 6,	26.38	18.14	8.24	" 6,	6.38	88.92	
" 10,	25.40	17.82	7.58	" 10,	6.38	88.90	
" 11,	26.10	18.24	7.86	" 11,	6.32	88.94	
April 30,	23.30	14.51	8.79	April 30,	6.57	87.10	3¼ pounds wheat bran, 3¼ pounds corn meal, 3¼ pounds new-process linseed meal, 20 pounds sugar beets, 15 pounds hay.
May 2,	24.67	16.37	8.36	May 2,	6.44	88.31	
" 5,	26.05	17.49	8.56	" 5,	6.35	87.58	
" 7,	23.93	15.00	8.93	" 7,	6.62	88.49	
" 9,	24.72	15.94	8.78	" 9,	6.45	87.39	
" 12,	24.88	14.96	9.92	" 12,	6.52	88.10	
May 20,	25.12	16.90	8.22	June 25,	6.54	88.02	3¼ pounds corn meal, 3¼ pounds wheat bran, 3¼ pounds old-process linseed meal, 20 pounds sugar beets, 15 pounds hay.
" 21,	25.76	17.46	8.30	" 28,	6.48	87.90	
" 23,	26.69	19.18	7.51	July 20,	7.59	84.76	
" 26,	25.61	17.52	8.09	" 22,	7.96	82.04	
" 28,	24.42	16.35	8.07	" 24,	8.11	78.69	
June 6,	25.76	17.95	7.81	July 28,	7.44	83.56	3¼ pounds corn meal, 3¼ pounds wheat bran, 3¼ pounds old-process linseed meal, 20 pounds rowen.
" 9,	27.70	19.86	7.84	August 1,	7.37	85.35	
" 12,	26.00	18.26	7.74	" 3,	8.06	82.99	
" 13,	26.26	18.38	7.88	September 16,	7.21	83.55	
June 17,	24.53	17.93	6.60	September 19,	6.75	86.59	3¼ pounds corn meal, 3¼ pounds wheat bran, 3¼ pounds old-process linseed meal, 20 pounds rowen.
" 18,	25.54	17.67	7.87	" 23,	6.61	86.40	

7. *Creamery Record, 1890* — Concluded.

Date of Sampling.	Analysis of Cream.			Date of Testing.	Analysis of Fat.		Average Daily Fodder Ration.
	Solids.	Fat.	Solids not Fat.		Volatile Acids.	Non-volatile Acids.	
1890.				**1890.**			
June 27,	24.30	17.34	6.96	September 30,	6.99	86.23	3¼ pounds corn meal, 3½ pounds wheat bran, 3¼ pounds new-process linseed meal, 20 pounds rowen.
" 29,	25.59	18.01	7.58	-	-	-	
July 2,	24.88	17.02	7.86	October 7,	6.74	86.68	
" 3,	22.94	15.97	6.97	" 9,	6.94	86.47	
July 29,	23.61	16.37	7.24	August 7,	6.78	86.61	3¼ pounds corn meal, 3½ pounds wheat bran, 3½ pounds new-process linseed meal, 5 pounds hay, 45 pounds vetch and oats.
August 1,	21.32	14.85	6.47	" 11,	6.78	87.14	
August 20,	26.14	18.84	7.30	August 20,	6.70	87.34	3¼ pounds corn meal, 3½ pounds wheat bran, 3½ pounds new-process linseed meal, 5 pounds hay, 50 pounds soja bean.
" 27,	26.44	19.07	7.27	" 27,	6.35	87.92	
September 5,	26.72	19.37	7.35	September 5,	6.25	88.40	
September 17,	24.20	16.97	7.23	September 17,	6.39	87.49	3¼ pounds corn meal, 3½ pounds wheat bran, 3½ pounds new-process linseed meal, 20 pounds rowen.
" 24,	22.07	14.87	7.20	" 24,	6.43	86.99	
November 7,	24.12	15.46	8.66	November 12,	7.36	86.35	3 pounds corn meal, 3 pounds wheat bran, 3 pounds cotton-seed meal, 20 pounds rowen.
" 12,	25.18	16.42	8.76	" 12,	6.94	87.04	
" 19,	25.15	15.96	9.19	" 19,	7.06	84.84	
December 2,	-	-	-	December 2,	6.10	84.35	3 pounds corn meal, 3 pounds wheat bran, 3 pounds gluten meal, 18 pounds rowen.
" 9,	26.17	17.21	8.96	" 9,	6.48	86.45	
" 16,	21.30	13.63	7.67	" 16,	6.87	85.50	
December 24,	25.95	17.29	8.66	December 24,	6.71	85.40	3 pounds corn meal, 3 pounds wheat bran, 3 pounds old-process linseed meal, 17 pounds rowen.
" 30,	24.78	16.32	8.46	" 30,	6.61	85.28	

The analyses of samples taken prior to May 20 were made according to the method of R. W. Moore, as modified by Waller. Those analyzed subsequent to that date were made according to the method of L. F. Nilson, as described in this report, on page 68.

Method of Milk Analysis.

Total Solids. — Evaporate a known quantity of milk (approximately 5 grams) in a weighed porcelain dish, containing 15 to 20 grams of pure, dry sand, on the water bath until apparently dry, then transfer to the air bath and dry at 100° to 105° C. to a constant weight, weighing at intervals of about an hour. In case of cream, use 2.5 to 3 grams for evaporation.

Fat. — Pulverize the sand containing the solids without removing from the dish, subsequently transfer to a filter, and exhaust with anhydrous, alcohol-free ether. Dry the fat obtained on the evaporation of the ether in an air bath at 100° to 105° C. to a constant weight.

Ash. — A weighed quantity of milk is evaporated to dryness with a few drops of nitric acid, and burned in a muffle at a low red heat until free from carbon.

Methods of Butter Analysis.

(1) *Moisture.* — Two and five-tenths to 3 grams are dried at 100° C. in an air bath.

(2) *Salt.* — Six to 7 grams of the butter are washed into a separatory funnel with hot water, and are well shaken, and allowed to stand until the fat has collected on top; the water is then drawn off, and a fresh quantity added, and shaken up with the butter. This is continued until 200 to 300 cubic centimetres of water have passed through the funnel. The washings are mixed, and made up to 500 cubic centimetres, and the chlorine determined in an aliquot part by means of silver nitrate. From the chlorine the salt is readily calculated.

(3) *Fat.* — Two and five-tenths to 3 grams of the fat freed from salt by the above operation (2), and from water by drying in the air bath, are dissolved in ether, and filtered from the curd into a tared flask. The ether is driven off, and the residual fat dried and weighed. In calculating the per cent., allowance is made for salt and water removed.

(4) *Casein.* — The residue remaining on the filter in (3) is tested for nitrogen by the Kjeldahl method. The factor 6.33 is used in reducing the per cent. of nitrogen found to casein.

Method for determining Volatile and Non-volatile Fatty Acids (first).

Directly after receiving the sample of cream from the Cooley cream-setting apparatus, the solids and fat were determined as usual. The cream was churned by vigorous shaking in a bottle, and was washed several times with cold water. The butter was then dissolved in ether, filtered from the curd, and the ether evaporated. About 2.5 grams of fat were placed in a weighed Erlenmeyer flask, the exact weight taken, and the fat saponified by 1 gram of potassium hydrate dissolved in 50 cubic centimetres of 70 per cent. alcohol. Heat is necessary for complete saponification. The alcohol is next driven off by continued heating in a boiling-water bath. The resulting soap is dissolved in 50 cubic centimetres of water, and decomposed by means of 20 cubic centimetres of dilute sulphuric acid (1 part of strong acid to 10 of water); 50 cubic centimetres are then distilled off, using a condenser for that purpose, the distillate passing through a filter. The distillate is titrated with one-tenth-normal sodium hydrate solution (4 grams of pure sodium hydrate per litre of water), 50 cubic centimetres of water are added to the contents of the flask, and an equal quantity distilled off, which is titrated as before. This treatment is continued until .1 cubic centimetre or less of the soda solution is required for neutralization. Phenolphthalein is used as an indicator. The volatile fatty acids are calculated from the sum of the cubic centimetres of soda solution required to neutralize all the distillates, calculating the acid as butyric. After cooling, the liquid remaining in the flask is poured off from the solidified non-volatile fatty acids through the same filter used in filtering the distillates. The solid fatty acids are washed repeatedly with hot water, until all traces of sulphuric acid are removed. The condenser is then washed out with hot alcohol, and the filter exhausted with the same solvent, the washings being collected in the flask. The alcohol is then driven off, the flask and contents dried at 100° C., and weighed, and the per cent. of non-volatile fatty acids calculated. The above method is that of R. W. Moore, as modified by Waller, and described in the "Journal of the American Chemical Society," No. 9, 1889, by R. W. Moore.

Method for determining Volatile and Non-volatile Fatty Acids contained in Butter (second).

The sample is prepared by churning the cream in a suitable bottle, washing the butter well with cold water, melting at 50° C. and filtering from the curd through a hot-water funnel. The fat is then heated in the air bath until free from water.

The method pursued in the determination of the volatile and non-volatile fatty acids is essentially that described by L. F. Nilson, in "Zeit. f. Anal. Chemie," 28, 2, 176.

Two and eight-tenths cubic centimetres to 2.9 cubic centimetres (approximately 2.5 grams) are measured into a tared Erlenmeyer flask of 250 cubic centimetres capacity, and the exact weight determined. Saponification is accomplished by adding 1 gram of potassium hydrate dissolved in 2 cubic centimetres of water, and 5 cubic centimetres of strong (95 per cent.) alcohol. The flask is provided with a reflux condenser, and heated until saponification is complete. The alcohol is then driven off, the last traces being removed by means of the following device: the flask is provided with a double perforated rubber cork, one hole carrying a glass tube reaching nearly to the bottom of the flask and provided above with a short rubber tube carrying a pinch-cock, the other connected by means of a rubber tube with a suction pump. By alternately opening and closing the pinch-cock while the pump is working, the last traces of alcohol can be readily removed from the soap.

Dissolve the soap thus obtained in 30 cubic centimetres of warm water, decompose with 20 cubic centimetres of a 20 per cent. solution of orthophosphoric acid, distil off the volatile acids through a condenser, filtering the distillate, and titrate with decinormal sodium hydrate, using phenolphthalein as indicator. The volatile acids are expelled from the flask by a current of steam. When the distillate amounts to 500 cubic centimetres, the operation is considered to be complete. The volatile acids are calculated as butyric.

The condenser and connections are rinsed back into the flask with boiling water, and the non-volatile acids washed with hot water, and filtered when cool through the same filter

that was used for the distillate. The washing is continued until no traces of phosphoric acid are left in the distillate. The filter is then exhausted with hot alcohol, allowing the solution to run into the flask. The alcohol is driven off on the water bath, and the non-volatile fatty acids dried at 100° C. in the air bath until they begin to gain weight.

Dairy Salt, 1890.

[Sent on from the Cummington Creamery.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	0.880	0.320	0.295
Sodium chloride,	97.877	98.009	98.513
Calcium chloride,	0.016	0.013	0.010
Calcium sulphate,	1.108	1.644	1.160
Magnesium chloride,	0.010	0.014	0.012
Magnesium oxide,	0.007	–	–
Insoluble matter,	0.102	0.020	0.010

Dairy Salt, 1890.

[I. and II. sent on from Amherst, Mass.; III. and IV. sent on from Northampton, Mass.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	0.235	0.200	0.855	0.565
Sodium chloride,	98.563	98.575	98.891	97.935
Calcium sulphate,	1.137	1.185	0.906	1.376
Calcium chloride,	0.045	0.029	0.293	0.097
Magnesium chloride,	0.020	0.007	0.055	0.027
Magnesium oxide,	–	0.004	–	–
Insoluble matter,	–	–	–	–

A good dairy salt ought to be of a uniform, fine granulation, of a white color, free from colored specks, free from any odor, of a pure saline test and of a neutral reaction. The chlorides of calcium and magnesia should not exceed one-tenth of one per cent.

II. — Feeding Experiments with Lambs, 1890.

The feeding experiments which are briefly described within a few subsequent pages are the first of a series devised for the purpose of ascertaining the cost of feed, when fattening lambs, by means of winter fodder rations, for the meat market.

The selection of animals, with reference to breeds best adapted for our purpose, was controlled by the temporary supply of our local market. Six lambs, three ewes and three wethers, bought of a farmer in our vicinity, Sept. 4, 1889, served for our observations. They were grades of a somewhat doubtful parentage; five showed some of the characteristics of Hampshire Downs, and one of Merinos. Each animal occupied, during the entire period of observation, a separate pen. They were shorn before being weighed, at the beginning of the experiment.

The daily diet of the entire lot consisted, during the first week, of rowen (dried second cut of grass lands). They were subsequently treated in two divisions, each comprising three animals. This division was made for the purpose of comparing the effect of two distinctly different daily fodder rations on the financial results of the operation. Division I. (Nos. 1–3) received a daily diet much richer in nitrogenous food constituents than the one adopted for Division II. (Nos. 4–6). This circumstance was brought about by feeding to the first division as grain feed a mixture of wheat bran and of gluten meal, and to the second division one consisting of a liberal proportion of corn meal, with some wheat bran and gluten meal. The coarse portion of the daily feed was in both cases essentially the same; namely, either rowen, or rowen and corn ensilage, or corn ensilage alone. It was cut before being mixed with the grain feed, when fed. The daily fodder ration was divided into two equal parts, and fed respectively in the morning and in the evening. The amount of feed left unconsumed, if any, was collected each morning and deducted from the daily ration offered the preceding day for consumption.

The observations in case of the first division of lambs (Nos. 1–3) were continued for 152 successive days (Sept.

5, 1889, to Feb. 4, 1890), while in case of the second division (Nos. 4–6) they were extended to March 18, 1890, and lasted thus for 194 consecutive days. Low rate of increase in live weight and local market condition advised the extension of the trial in the latter case.

The three lambs of the first division gained within 152 days, in live weight, in the aggregate 107½ pounds, or each individual on an average 35⅚ pounds; while those of the second division (Nos. 4–6) gained during 194 days, in the aggregate, only 86 pounds, or each individual on an average 28⅔ pounds.

Some of the essential points of interest in the experiment here under discussion are stated in some subsequent pages, under the following headings: —

1. Weight of lambs.
2. Cost of lambs.
3. Character and cost of feed consumed.
4. Gain in live weight during the observation.
5. Financial statement.
6. Conclusion.
7. Detailed statement of feeding record.

1. Weight of Lambs.

The aggregate live weight of six lambs when bought amounted to 450½ pounds.

The wool secured before the beginning of the feeding experiments amounted to 22¼ pounds.

	Live Weights when bought.	Wool removed.	Live Weights at the Beginning of Trial.
1, . .	82.50 pounds.	3.50 pounds.	79.00 pounds (wether).
2, . .	69.50 pounds.	3.50 pounds.	66.00 pounds (ewe).
3, . .	75.00 pounds.	4.25 pounds.	70.75 pounds (ewe).
4, . .	71.00 pounds.	3.50 pounds.	67.50 pounds (ewe).
5, . .	70.00 pounds.	3.75 pounds.	66.25 pounds (wether).
6, . .	82.50 pounds.	3.75 pounds.	78.75 pounds (wether).
	450.50 pounds.	22.25 pounds.	428.25 pounds.

Division I. consisted of lambs Nos. 1–3; its aggregate live weight was 215.75 pounds at the beginning of the experiment.

Division II. consisted of lambs Nos. 4–6; its aggregate live weight at the beginning of the experiment was 212.50 pounds.

2. *Cost of Lambs.*

The entire lot was bought at six cents per pound of live weight, and the sum paid for 450.5 pounds of the original weight amounted to $27.03.

The wool secured before the beginning of the feeding trial, which amounted to 22.25 pounds, was returned at 23 cents per pound. The sum realized by that transaction was $5.12. Allowing the deduction of $5.12 on the first cost of the lambs, which was $27.03, it will be found that their actual cost at the beginning of the experiment was but $21.91, or 5.12 cents per pound of live weight. The live weight without the removed wool was 428.25 pounds.

Division I.

1.	79.00 pounds of live weight, at 5.12 cents,	$4 05	$11 01
2.	66.00 pounds of live weight, at 5.12 cents,	3 38	
3.	70.00 pounds of live weight, at 5.12 cents,	3 58	

Division II.

4.	67.00 pounds of live weight, at 5.12 cents,	$3 43	$10 85
5.	66.25 pounds of live weight, at 5.12 cents,	3 39	
6.	78.75 pounds of live weight, at 5.12 cents,	4 03	

3. *Character and Cost of the Feed consumed.*

To secure a normal and uniform condition of the animals selected for a comparative test of different fodder rations, with reference to their influence on the financial results of the operation, nothing but rowen was fed to the entire lot for ten days preceding the experiment (September 4 to September 16). Subsequently a division of animals was made. Three lambs, 1–3, were fed with daily rations richer in digestible nitrogenous food constituents than those fed to the remaining number, 4–6.

The daily feed of the first division (1–3) contained on an average from 4.5 to 5.5 parts of digestible non-nitrogenous

food constituents to one part of digestible nitrogenous food constituents, 1 : 4.5 to 1 : 5.5.

The daily diet of the second division (4–6) contained, during a corresponding period of the feeding experiment, one part of digestible nitrogenous food constituents to from 6.99 to 7.3 parts of digestible non-nitrogenous food constituents, 1 : 6.99 to 1 : 7.3. Subsequently a diet similar to that adopted for the first division was substituted.

Fodder Combinations used in Division I. (1–3).

The daily quantity of the subsequently stated fodder rations was regulated by the appetite of each animal.

a. September 16 to September 30 : —

Two pounds of rowen, 1 pound of a mixture consisting of wheat bran, 2 weight parts ; gluten meal, 1 weight part.

Nutritive ratio, 1 : 4.75.

b. October 1 to December 31 : —

Two pounds of rowen, 1 pound of a mixture consisting of wheat bran and gluten meal, equal weights.

Nutritive ratio, 1 : 4.55.

c. January 2 to January 20 : —

One pound of rowen, 3½ pounds of corn ensilage, 1 pound of the same grain mixture as in ration *b*.

Nutritive ratio, 1 : 5.09.

d. January 21 to February 3 : —

Seven pounds of corn ensilage, 1 pound of grain mixture as in ration *b*.

Nutritive ratio, 1 : 5.5.

Cost of Above Fodder Rations for Weights stated.

	a.	*b.*	*c.*	*d.*
Total cost of feed consumed (cents), . .	2.45	2.51	2.24	1.97
Manurial value obtainable (cents), . .	1 13	1.15	1.10	1.04
Net cost of feed (cents), ...	1.32	1.36	1 14	0.93

Fodder Combinations used in Division II. (4–6).

a. September 16 to December 31 : —

Two pounds of rowen, ½ pound of a mixture consisting of corn meal, 10 weight parts ; wheat bran, 2 weight parts ; gluten meal, 1 weight part.

Nutritive ratio, 1 : 7.00.

b. January 2 to January 20 : —

One pound of rowen, 3½ pounds of corn ensilage, ½ pound of the same grain mixture as in preceding ration *a*.

Nutritive ratio, 1 : 7.3.

c. February 4 to February 15 : —

Six pounds of corn ensilage, 1 pound of a mixture consisting of wheat bran and gluten meal, equal weights.

Nutritive ratio, 1 : 5.7.

d. February 18 to March 17 : —

One and one-half pounds of corn fodder, 1 pound of a mixture the same as in ration *c*.

Nutritive ratio, 1 : 4.88.

Cost of Fodder Rations used in Division II.

	a.	*b.*	*c.*	*d.*
Total cost of feed consumed (cents),	1.98	1 71	1.83	1.56
Manurial value obtainable (cents),	0.71	0.50	0.97	0.89
Net cost of feed (cents),	1.27	1.21	0.86	0.67

The customary deduction of twenty per cent. of the manurial value of the feed consumed is adopted in the above valuation. Net cost of feed represents its first cost, or local market value, less eighty per cent. of the market value of its manurial constituents.

Cost of Fodder Articles used in the Experiment.

Rowen, per ton,	$15 00
Corn ensilage, per ton,	2 75
Corn meal, per ton,	19 00
Wheat bran, per ton,	17 00
Gluten meal, per ton,	23 00

4. Gain in Live Weight during the Experiment.

Division I. (1–3). Time of Observation extended over 152 Days.

	Live Weight at the Beginning of the Experiment (Pounds).	Live Weight at the Time of Killing before shearing (Pounds).	Gain in Live Weight during the Experiment (Pounds).
One,	79.00	118 25	39.25
Two,	66.00	98.50	32.50
Three,	70 75	106.50	35.75
	215.75	323 25	107.50

Division II. (4–6). Time of Observation extended over 194 Days.

	Live Weight at the Beginning of the Experiment (Pounds).	Live Weight at the Time of Killing before shearing (Pounds).	Gain in Live Weight during the Experiment (Pounds).
Four,	67.50	102.50	35.00
Five,	66.25	86 50	20.50
Six,	78 75	109.50	30.75
	212.50	298.50	86.25

Division I., entire lot gained in live weight on an average per day, 0.706 pounds.

Division II., entire lot gained in live weight on an average per day, 0.445 pounds.

The Amount of Raw Wool secured after the Close of the Experiments. Division I. (1–3).

	Live Weight, with Wool.	Live Weight after shearing.	Amount of Wool obtained.	
	Pounds.	Pounds.	Pounds.	Ounces.
One,	118.25	114.38	3	14
Two,	98.50	94.60	3	15
Three,	106.50	102.00	4	8
	323.25	310.98	12	5

Division II. (4–6).

	Live Weight, with Wool.	Live Weight after shearing.	Amount of Wool obtained.	
	Pounds.	Pounds.	Pounds.	Ounces.
Four,	102.50	99.25	3	4
Five,	86.50	82.00	4	8
Six,	109.50	105.00	4	8
	298.50	286.25	12	4

Division I. yielded 12 pounds, 5 ounces of wool.

Division II. yielded 12 pounds, 4 ounces of wool.

The former is the result of 152 days of growth, and the latter that of 194 days. Lamb No. 5 is a Merino grade; the remainder are Hampshire Down grades.

5. *Financial Statement.*

The wool was sold at 23 cents per pound, the pelts brought 12½ cents each.

Division I. (1–3).

The difference between the live weights of the animals at the close of the experiment, after shearing, and the dressed lambs, when sold, amounted on an average to 44.3 per cent.

Yield Dressed Weights.

1.	66 pounds, at 11 cents per pound, . . .	$7 26
2.	54 pounds, at 11 cents per pound, . . .	5 94
3.	60 pounds, at 11 cents per pound, . . .	6 60
	180 pounds, ...	$19 80

Division II. (4–6).

The difference between the live weights of the animals at the close of the experiment, after shearing, and the dressed lambs, when sold, amounted on an average to 46.3 per cent.

Yield Dressed Weights.

4.	54 pounds, at 11 cents per pound, . . .	$5 94
5.	46 pounds, at 11 cents per pound, . . .	5 06
6.	60.50 pounds, at 11 cents per pound, . . .	6 65
	160.50 pounds, ...	$17 65

Division I.

	1.	2.	3.	
Cost of lamb, ...	$4 05	$3 38	$3 58	$22 78
Cost of feed consumed, . .	4 58	3 11	4 08	
	$8 63	$6 49	$7 66	
Value received for meat, .	$7 26	$5 94	$6 60	$28 70
Value received for wool and pelt, ...	1 02	1 04	1 17	
Value of obtainable manure, .	2 19	1 52	1 96	
	$10 47	$8 50	$9 73	

Difference in favor, $5.92.

Division II.

	4.	5.	6.	
Cost of lamb,	$3 43	$3 39	$4 03	$22 34
Cost of feed consumed,	4 64	3 03	3 82	
	$8 07	$6 42	$7 85	
Value received for meat,	$5 94	$5 06	$6 65	$25 37
Value received for wool and pelt,	0 89	1 17	1 17	
Value of obtainable manure,	1 71	1 23	1 55	
	$8 54	$7 46	$9 37	

Difference in favor, $3.03.

6. *Conclusions.*

1. The well-established superior feeding effect of a daily diet rich in digestible nitrogenous food constituents, when raising lambs for the meat market, is shown in a marked degree in Division I., as compared with those in Division II.

2. The good services of the particular fodder rations used in case of the first division of lambs is shown by a fair rate of increase in live weight.

3. Corn ensilage as a substitute in part for rowen has given very satisfactory results.

4. The profit obtained with reference to both divisions of lambs is due to the commercial value of the fertilizing constituents contained in the obtainable manure. This value amounts in the case of the first division of lambs to $5.67. To appreciate this value properly, it needs to be considered that, in determining the financial results of the experiment, all home-raised fodder articles are counted on the basis of their retail selling price in our vicinity. Sheep are known to produce one of the best home-made manures.

The decidedly beneficial influence of a rational and liberal system of stock-feeding on the financial results of a mixed farm management cannot find *its full expression* in the mere presentation of the results of a feeding experiment, however carefully the matter may be arranged.

7. *Detailed Statement of Feeding Record.*

Sheep No. 1.

FEEDING PERIODS.	Feed consumed (Pounds) per Day.				Pounds of Dry Matter in Daily Fodder consumed.	Gain in Live Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound of Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Wheat Bran.	Gluten Meal.	Rowen.	Corn Ensilage.					
1889-1890.									
Sept. 17 to Sept. 30, .	0.74	0.37	1.93	–	2.67	0.32	8.34	1 : 4.74	86.00
Oct. 1 to Dec. 3, .	0.69	0.69	2.52	–	3.43	0.26	13.19	1 : 4.55	96.75
Dec. 17 to Dec 31, .	0.75	0.75	2.87	–	3.84	0.30	12.80	1 : 4.59	111.00
Jan. 2 to Jan. 20, .	0.77	0.77	1.54	4.05	3.82	0.26	14.69	1 : 5.09	114.50
Jan. 21 to Feb. 3, .	0.63	0.63	–	6.29	2.84	0.02	142.00	1 : 5.52	117.50

*Total Amount of Feed consumed from Sept. 5, 1889, to Feb. 3, 1890.**

	Dry Matter (Pounds).	Cost.	Fertilizer Value.
104.57 pounds wheat bran, . . .	94.88	$0 89	$0 71
97.07 pounds gluten meal, . . .	87.56	1 12	0 79
310.00 pounds rowen, ...	268.05	2 33	1 07
178.50 pounds corn ensilage, . . .	48.42	0 24	0 15
	498.91	$4 58	$2 72

* Includes the feed during the 12 days preceding the experiment proper.

	Pounds.
Live weight of animal at beginning of experiment, . .	79.00
Live weight at time of killing, ...	118.25
Live weight gained during experiment, ...	39.25
Average gain in weight per day, ...	0.25
Dressed weight of animal, ...	66.00
Loss in weight by dressing, . . 52.25 pounds, or 44.19 per cent.	
Pounds of dry matter fed to produce 1 pound of live weight,	12.71
Cost of feed per pound of live weight gained, . . .	11.67 cents
Net cost of feed per pound gained after deducting 20 per cent. of manurial value, ...	6.11 cents.

7. *Detailed Statement of Feeding Record* — Continued.

Sheep No. 1.

FEEDING PERIODS.	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Total Amount of Corn Ensilage consumed (Pounds).	Nutritive Ratio of Feed.	Live Weight of Animal at Beginning of Period (Pounds).	Live Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
1889-1890.								
Sept. 17 to Sept. 30, .	10.33	5.17	27.00	–	1 : 4.74	84 00	88.50	0.32
Oct. 1 to Dec. 3, .	44.31	44.31	161.00	–	1 : 4.55	88.50	105.00	0.26
Dec. 17 to Dec. 31, .	11.25	11.25	43.00	–	1 : 4.59	108.00	112.50	0.30
Jan. 2 to Jan. 20, .	14.63	14.63	29.25	77.00	1 : 5.09	113.00	118.00	0.26
Jan. 21 to Feb. 3, .	8.88	8.88	–	88.00	1 : 5.52	118.00	118.25	0.02

Total Amount of Feed consumed from Sept. 17, 1889, to Feb. 3, 1890.

	Pounds.
99.90 pounds wheat bran, equal to dry matter, . . .	90.64
94.74 pounds gluten meal, equal to dry matter, . . .	85.46
281.00 pounds rowen, equal to dry matter, ...	242.98
178.50 pounds corn ensilage, equal to dry matter, . . .	48.42
Total amount of dry matter, ...	467.50

	Pounds.
Live weight of animal at beginning of experiment, . .	84.00
Live weight of animal at time of killing, ...	118.25
Live weight gained during experiment, ...	34.25
Dressed weight at time of killing, ...	66.00
Loss in weight by dressing, . . 52.25 pounds or 44.19 per cent.	

Cost of Feed consumed during Experiment.

99.90 pounds wheat bran, at $17.00 per ton, ...	$0 85
94.74 pounds gluten meal, at $23.00 per ton, ...	1 09
281.00 pounds rowen, at $15.00 per ton, ...	2 11
178.50 pounds corn ensilage, at $2.75 per ton, ...	0 24
	$4 29

13.65 pounds of dry matter yielded 1 pound of live weight.
Cost of feed for production of 1 pound of live weight, 12.52 cents.

7. *Detailed Statement of Feeding Record* — Continued.

Sheep No. 2.

FEEDING PERIODS.	Feed consumed (Pounds) per Day.				Pounds of Dry Matter in Daily Fodder consumed.	Gain in Live Weight per Day (Pounds).	Pounds of Dry Matter produced one Pound of Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Wheat Bran.	Gluten Meal.	Rowen.	Corn Ensilage.					
1889-1890.									
Sept. 17 to Sept. 30, .	0.61	0.31	1.43	–	2.07	0.50	4.14	1:4.64	70.00
Oct. 1 to Dec. 3, .	0.51	0.51	1.66	–	2.36	0.22	10.73	1:4.45	82.75
Dec. 17 to Dec. 31, .	0.51	0.51	1.23	–	1.98	0.12	16.50	1:4.20	90.25
Jan. 2 to Jan. 20, .	0.50	0.50	0.58	2.92	2.19	0.29	7.55	1:5.01	95.00
Jan. 21 to Feb. 3, .	0.58	0.58	–	4.79	2.35	0.11	21.36	1:5.24	98.00

*Total Amount of Feed consumed from Sept. 5, 1889, to Feb. 3, 1890.**

	Dry Matter (Pounds).	Cost.	Fertilizer Value.
79.61 pounds wheat bran, . . .	72.23	$0 68	$0 54
72.99 pounds gluten meal, . . .	65.84	0 84	0 59
188.00 pounds rowen, ...	162.56	1 41	0 65
130.75 pounds corn fodder, . . .	35.36	0 18	0 11
	335.99	$3 11	$1 89

* Includes the feed during the 12 days preceding the experiment proper.

	Pounds.
Live weight of animal at beginning of experiment, . . .	66.00
Live weight at time of killing, ...	98.50
Live weight gained during experiment, ...	32.50
Average gain in weight per day, ...	0.21
Dressed weight of animal, ...	54.00
Loss in weight by dressing, . .	44.50 pounds, or 45.18 per cent.
Pounds of dry matter fed to produce 1 pound of live weight, .	10.34
Cost of feed per pound of live weight gained, . . .	9.57 cents.
Net cost of feed per pound gained after deducting 20 per cent. of manurial value, ...	4.92 cents.

7. *Detailed Statement of Feeding Record* — Continued.

Sheep No. 2.

FEEDING PERIODS.	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Total Amount of Corn Ensilage consumed (Pounds).	Nutritive Ratio of Feed.	Live Weight of Animal at Beginning of Period (Pounds).	Live Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
1889-1890.								
Sept. 17 to Sept. 30, .	8 56	4.28	20.00	–	1.4.64	67.50	74.50	0.50
Oct. 1 to Dec. 3, .	32.63	32.63	106.00	–	1:4.45	74.50	88.50	0.22
Dec. 17 to Dec. 31, .	7.63	7.63	18.50	–	1:4.20	88.50	90.50	0.12
Jan. 2 to Jan. 20, .	9.50	9.50	11.00	55.50	1:5.01	91.50	97.00	0.29
Jan. 21 to Feb. 3, .	8.12	8.12	–	67.00	1:5.24	97.00	98.50	0.11

Total Amount of Feed consumed from Sept. 17, 1889, to Feb. 3, 1890.

	Pounds.
74.94 pounds wheat bran, equal to dry matter, . . .	67.99
70.66 pounds gluten meal, equal to dry matter, . . .	63.74
168.00 pounds rowen, equal to dry matter, ...	145.27
126.50 pounds corn ensilage, equal to dry matter, . . .	35.36
Total amount of dry matter, ...	312.36

	Pounds
Live weight of animal at beginning of experiment, . . .	67.50
Live weight at time of killing, ...	98.50
Live weight gained during experiment, ...	31.00
Dressed weight at time of killing, ...	54.00
Loss in weight by dressing, . . 44.50 pounds, or 45.18 per cent.	

Cost of Feed consumed during Experiment.

74.94 pounds wheat bran, at $17.00 per ton, ...	$0 64
70.66 pounds gluten meal, at $23 00 per ton, ...	0 81
168.00 pounds rowen, at $15.00 per ton, ...	1 26
130.75 pounds corn ensilage, at $2.75 per ton, ...	0 18
	$2 89

10.08 pounds of dry matter yielded 1 pound of live weight.
Cost of feed for the production of 1 pound of live weight, 9.32 cents.

7. *Detailed Statement of Feeding Record* — Continued.

Sheep No. 3.

FEEDING PERIODS.	Feed consumed (Pounds) per Day.				Pounds of Dry Matter in Daily Fodder consumed.	Gain in Live Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound of Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Wheat Bran.	Gluten Meal.	Rowen.	Corn Ensilage.					
1889-1890.									
Sept. 17 to Sept. 30, .	0.71	0.35	1.96	–	2.65	0.30	8.83	1 : 4.78	79.25
Oct. 1 to Dec. 3, .	0.64	0.64	2.37	–	3.21	0.17	18.88	1 : 4.67	88.75
Dec. 17 to Dec. 31, .	0.63	0.63	2.00	–	2.87	0.30	9.57	1 : 4.42	97.25
Jan. 2 to Jan. 20, .	0.62	0.62	1.08	3.07	2.88	0.26	11.08	1 : 4.97	100.75
Jan. 21 to Feb. 3, .	0.58	0.58	–	5.02	2.41	0.18	13.39	1 : 5.29	105.00

*Total Amount of Feed consumed from Sept. 5, 1889, to Feb. 3, 1890.**

	Dry Matter (Pounds).	Cost.	Fertilizer Value.
95.79 pounds wheat bran, . . .	86.91	$0 81	$0 65
88.49 pounds gluten meal, . . .	79.82	1 02	0 72
274.25 pounds rowen, ...	237.14	2 06	0 95
149.00 pounds corn ensilage, . . .	40.23	0 19	0 12
	444.10	$4 08	$2 44

* Includes the feed during 12 days preceding the experiment proper.

	Pounds.
Live weight of animal at beginning of experiment, . . .	71.00
Live weight at time of killing, ...	106.50
Live weight gained during experiment, ...	35.50
Average gain in weight per day, ...	0.23
Dressed weight of animal, ...	60.00
Loss in weight by dressing, . . .	46.50 pounds, or 43.66 per cent.
Pounds of dry matter fed to produce 1 pound of live weight, .	12.51
Cost of feed per pound of live weight gained, . . .	11.49 cents.
Net cost of feed per pound gained after deducting 20 per cent. of manurial value, ...	6.00 cents.

7. Detailed Statement of Feeding Record—Continued.

Sheep No. 3.

FEEDING PERIODS.	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Total Amount of Corn Ensilage consumed (Pounds).	Nutritive Ratio of Feed.	Live Weight of Animal at Beginning of Period (Pounds).	Live Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
1889-1890.								
Sept. 17 to Sept. 30, .	9.92	4.96	27.50	–	1:4.78	78.25	82.50	0.30
Oct. 1 to Dec. 3, .	41.06	41.06	151.50	–	1:4.67	82.50	93.50	0.17
Dec. 17 to Dec. 31, .	9.50	9.50	30.00	–	1:4.42	95.00	99.50	0.30
Jan. 2 to Jan. 20. .	11.87	11.87	20.50	58.25	1:4.97	99.00	104.00	0.26
Jan. 21 to Feb. 3, .	8.12	8.12	–	70.25	1:5.29	104.00	106.50	0.18

Total Amount of Feed consumed from Sept. 17, 1889, to Feb. 3, 1890.

	Pounds.
91.12 pounds wheat bran, equal to dry matter, ...	82.67
86.16 pounds gluten meal, equal to dry matter, . . .	77.72
252.25 pounds rowen, equal to dry matter, ...	218.12
149.00 pounds corn ensilage, equal to dry matter, . . .	40.23
Total amount of dry matter, ...	418.74

	Pounds.
Live weight of animal at beginning of experiment, . . .	78.25
Live weight at time of killing, ...	106 50
Live weight gained during experiment, ...	28.25
Dressed weight at time of killing, ...	60.00
Loss in weight by dressing, . . . 46.50 pounds, or 43.66 per cent.	

Cost of Feed consumed during Experiment.

91.12 pounds wheat bran, at $17.00 per ton, ...	$0 77
86.16 pounds gluten meal, at $23.00 per ton, ...	0 99
252.25 pounds rowen, at $15.00 per ton, ...	1 89
149.00 pounds corn ensilage, at $2.75 per ton, ...	0 20
	$3 85

14.82 pounds of dry matter yielded 1 pound of live weight.
Cost of feed for the production of 1 pound of live weight, 13.59 cents.

7. *Detailed Statement of Feeding Record* — Continued.

Sheep No. 4.

FEEDING PERIODS.	Feed consumed (Pounds) per Day.						Pounds of Dry Matter in Daily Fodder consumed.	Gain in Live Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound of Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Corn Meal.	Wheat Bran.	Gluten Meal.	Rowen.	Corn Ensilage.	Corn Fodder.					
1889-1890.											
Sept. 17 to Dec. 3,	0.54	0.11	0.05	2.56	–	–	2.84	0.13	21.85	1 : 6.99	82.00
Dec. 17 to Dec. 31,	0.58	0.12	0.06	1.97	–	–	2.37	0.02	118.50	1 : 7.01	89.75
Jan. 2 to Jan. 20,	0.58	0.12	0.06	1.16	2.05	–	2.22	0.14	15.86	1 : 7.30	91.50
Feb. 4 to Feb. 15,	–	0.50	0.50	–	5.67	–	2.43	0.33	7.36	1 : 5.76	98.50
Feb. 18 to Mar. 17,	–	0.55	0.55	–	–	1.59	2.27	0.03	75.67	1 : 4.88	101.50

*Total Amount of Feed consumed from Sept. 5, 1889, to March 17, 1890.**

	Dry Matter (Pounds).	Cost.	Fertilizer Value.
78.21 pounds corn meal, ...	69.09	$0 75	$0 25
41.99 pounds wheat bran, . . .	38.10	0 36	0 28
32.25 pounds gluten meal, . . .	29.09	0 37	0 26
305.50 pounds rowen, ...	264.16	2 70	1 06
185.75 pounds corn ensilage, . . .	50.25	0 26	0 14
54.00 pounds corn fodder, . . .	42 23	0 20	0 14
	492.92	$4 64	$2 13

* Includes the feed during 12 days preceding the experiment proper.

	Pounds.
Live weight of animal at beginning of experiment, . . .	67 50
Live weight at time of killing, ...	102.25
Live weight gained during experiment, ...	34.75
Average gain in weight per day, ...	0.18
Dressed weight of animal, ...	54.00
Loss in weight by dressing, . . . 48.25 pounds, or 47.19 per cent.	
Pounds of dry matter fed to produce 1 pound of live weight, .	14.19
Cost of feed per pound of live weight gained, . . .	13.35 cents.
Net cost of feed per pound gained after deducting 20 per cent. of manurial value, ...	8.46 cents.

7. *Detailed Statement of Feeding Record* — Continued.

Sheep No. 4.

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Corn Ensilage consumed (Pounds).	Total Amount of Corn Fodder consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Nutritive Ratio of Feed.	Live Weight of Animal at Beginning of Period (Pounds).	Live Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
1889-1890.										
Sept. 17 to Dec. 3,	41.88	4.19	8.38	–	–	200.00	1 : 6.99	74.50	85.00	0.13
Dec. 17 to Dec. 31,	8.65	0.87	1.73	–	–	29 50	1 : 7.01	90.00	90.25	0.02
Jan. 2 to Jan. 20,	10.96	1.10	2.19	39.00	–	22.00	1 : 7.30	90.00	92.75	0.14
Feb. 4 to Feb. 15,	–	6.00	6.00	68.00	–	–	1 : 5.76	96.50	100.50	0.33
Feb. 18 to Mar. 17,	–	15.50	15.50	–	44.50	–	1 : 4.88	101.50	102.25	0.03

Total Amount of Feed consumed from Sept. 17, 1889, to March 17, 1890.

	Pounds.
75.52 pounds corn meal, equal to dry matter,	66.71
31.98 pounds gluten meal, equal to dry matter,	28.85
41.45 pounds wheat bran, equal to dry matter,	37.61
283.50 pounds rowen, equal to dry matter,	245.14
185.75 pounds corn ensilage, equal to dry matter,	50.25
54.00 pounds corn fodder, equal to dry matter,	42.23
Total amount of dry matter,	470.79

	Pounds.
Live weight of animal at beginning of experiment,	74.50
Live weight at time of killing,	102.25
Live weight gained during experiment,	27.75
Dressed weight at time of killing,	54.00
Loss in weight by dressing,	48 25 pounds, or 47.19 per cent.

Cost of Feed consumed during Experiment.

75.52 pounds corn meal, at $19 00 per ton,	$0 72
31.98 pounds gluten meal, at $23.00 per ton,	0 37
41 45 pounds wheat bran, at $17.00 per ton,	0 35
283 50 pounds rowen, at $15.00 per ton,	2 13
185.75 pounds corn ensilage, at $2.75 per ton,	0 26
54.00 pounds corn fodder, at $7.50 per ton,	0 20
	$4 03

16.97 pounds of dry matter fed yielded 1 pound of live weight.
Cost of feed for the production of 1 pound of live weight, 14 50 cents.

7. *Detailed Statement of Feeding Record* — Continued.

Sheep No. 5.

FEEDING PERIODS.	Feed consumed (Pounds) per Day.						Pounds of Dry Matter in Daily Fodder consumed.	Gain in Live Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound of Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Corn Meal.	Wheat Bran.	Gluten Meal.	Rowen.	Corn Ensilage.	Corn Fodder.					
1889-1890.											
Sept. 17 to Dec. 3,	0.40	0.08	0.04	1.80	–	–	2.02	0.12	16.83	1 : 6.99	72.75
Dec. 17 to Dec. 31,	0.39	0.08	0.04	1.47	–	–	1.72	-0.23	–	1 : 7.00	75.75
Jan. 2 to Jan. 20,	0.41	0.08	0.04	0.53	2.84	–	1.70	0.36	4.72	1 : 8.58	79.00
Feb. 4 to Feb. 15,	–	0.39	0.39	–	3.50	–	1.65	0.25	6.60	1 : 5.37	84.25
Feb. 18 to Mar. 17,	–	0.43	0.43	–	–	0.93	1.52	-0.02	–	1 : 4.53	86.75

*Total Amount of Feed consumed from Sept. 5, 1889, to March 17, 1890.**

	Dry Matter (Pounds).	Cost.	Fertilizer Value.
59.85 pounds corn meal, . . .	52.87	$0 57	$0 19
33.32 pounds wheat bran, . . .	30.23	0 29	0 22
25.42 pounds gluten meal, . . .	22.93	0 29	0 20
203.50 pounds rowen, ...	175.97	1 53	0 70
166.00 pounds corn ensilage, . . .	44.90	0 23	0 13
31.50 pounds corn fodder, . . .	24.74	0 12	0 08
	351.64	$3 03	$1 52

* Includes the feed during 12 days preceding the experiment proper.

	Pounds.
Live weight of animal at beginning of experiment, . . .	66.25
Live weight at time of killing, ...	86.50
Live weight gained during experiment, ...	20.25
Average gain in weight per day, ...	0.10
Dressed weight of animal, ...	46.00
Loss in weight by dressing, . . 40.50 pounds, or 46.82 per cent.	
Pounds of dry matter fed to produce 1 pound of live weight, .	17.36
Cost of feed per pound of live weight gained, . . .	14.96 cents.
Net cost of feed per pound gained after deducting 20 per cent. of manurial value, ...	8.94 cents.

7. *Detailed Statement of Feeding Record* — Continued.

Sheep No. 5.

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Corn Ensilage consumed (Pounds).	Total Amount of Corn Fodder consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Nutritive Ratio of Feed.	Live Weight of Animal at Beginning of Period (Pounds).	Live Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
1889-1890.										
Sept. 17 to Dec. 3,	31.00	3.10	6.20	-	-	140.50	1:6.99	66.25	75.50	0.12
Dec. 17 to Dec. 31,	5.87	0.59	1.17	-	-	22.00	1:7.00	77.50	74.00	-0.23
Jan. 2 to Jan. 20,	7.70	0.77	1.54	54.00	-	10.00	1:8.58	75.00	81.75	0.36
Feb. 4 to Feb. 15,	-	4.63	4.63	42.00	-	-	1:5.37	83.00	86.00	0.25
Feb. 18 to Mar. 17,	-	12.13	12.13	-	26.00	-	1:4.53	87.00	86.50	-0.02

Total Amount of Feed consumed from Sept. 17, 1889, to March 17, 1890.

	Pounds.
57.16 pounds corn meal, equal to dry matter,	50.49
25.15 pounds gluten meal, equal to dry matter,	22.69
32.78 pounds wheat bran, equal to dry matter,	29.74
182.50 pounds rowen, equal to dry matter,	157.81
166.00 pounds corn ensilage, equal to dry matter,	40.90
31.50 pounds corn fodder, equal to dry matter,	24.74
Total amount of dry matter,	330.37

	Pounds.
Live weight of animal at beginning of experiment,	66.25
Live weight at time of killing,	86.50
Live weight gained during experiment,	20.25
Dressed weight at time of killing,	46.00
Loss in weight by dressing,	40.50 pounds, or 46.82 per cent.

Cost of Feed consumed during Experiment.

57.16 pounds corn meal, at $19.00 per ton,	$0 54
25.15 pounds gluten meal, at $23.00 per ton,	0 29
32.78 pounds wheat bran, at $17.00 per ton,	0 28
182.50 pounds rowen, at $15.00 per ton,	1 37
166.00 pounds corn ensilage, at $2.75 per ton,	0 23
31.50 pounds corn fodder, at $7.50 per ton,	0 12
	$2 83

16.31 pounds of dry matter fed yielded 1 pound of live weight.
Cost of feed for the production of 1 pound of live weight, 13.98 cents.

7. *Detailed Statement of Feeding Record*—Continued.

Sheep No. 6.

FEEDING PERIODS.	Feed consumed (Pounds) per Day.						Pounds of Dry Matter in Daily Fodder consumed.	Gain in Live Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound of Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Corn Meal.	Wheat Bran.	Gluten Meal.	Rowen.	Corn Ensilage.	Corn Fodder.					
1889-1890.											
Sept. 17 to Dec. 3,	0.48	0.10	0.05	2.21	–	–	2.47	0.17	14.53	1 : 6 99	91.25
Dec. 17 to Dec. 31,	0.56	0.11	0 06	2.20	–	–	2.54	0.23	11.05	1 : 7.00	99.50
Jan. 2 to Jan. 20,	0.48	0.10	0.05	0.97	1.89	–	1.91	0.16	11.94	1 : 7.90	102.00
Feb. 4 to Feb. 15,	–	0.50	0.50	–	5.42	–	2.37	0.21	11.29	1 : 5.68	107.50
Feb. 18 to Mar. 17,	–	0.55	0.55	–	–	1.38	2.10	–	–	1 : 4.70	108.00

*Total Amount of Feed consumed from Sept. 5, 1889, to March 17, 1890.**

	Dry Matter (Pounds).	Cost.	Fertilizer Value.
71.31 pounds corn meal,	62.99	$0 68	$0 23
40.61 pounds wheat bran,	36.85	0 35	0 27
31.55 pounds gluten meal,	28.45	0 36	0 25
264.50 pounds rowen,	228.71	1 98	0 92
193.50 pounds corn ensilage,	52.34	0 27	0 15
43.50 pounds corn fodder,	34.40	0 17	0 11
	443.74	$3 81	$1 93

* Includes the feed during 12 days preceding the experiment proper.

	Pounds.
Live weight of animal at beginning of experiment,	79.00
Live weight at time of killing,	109.50
Live weight gained during experiment,	30.50
Average gain in weight per day,	0.16
Dressed weight of animal,	60.50
Loss in weight by dressing,	49 pounds, or 44.75 per cent.
Pounds of dry matter fed to produce 1 pound of live weight,	14.55
Cost of feed per pound of live weight gained,	12.49 cents.
Net cost of feed per pound gained after deducting 20 per cent. of manurial value,	7.44 cents.

7. *Detailed Statement of Feeding Record* — Concluded.

Sheep No. 6.

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Corn Ensilage consumed (Pounds).	Total Amount of Corn Fodder consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Nutritive Ratio of Feed.	Live Weight of Animal at Beginning of Period (Pounds).	Live Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
1889-1890.										
Sept. 17 to Dec. 3,	37.10	3.71	7.42	–	–	172.00	1 : 6.99	83.25	96.75	0.17
Dec. 17 to Dec. 31,	8.46	0.85	1.69	–	–	33.00	1 : 7.00	98.00	101.50	0.23
Jan. 2 to Jan. 20,	9.13	0.91	1.83	36.00	–	18.50	1 : 7.90	100.50	103.50	0.16
Feb. 4 to Feb. 15,	–	6.00	6.00	65.00	–	–	1 : 5.68	105.50	108.00	0.21
Feb. 18 to Mar. 17,	–	15.50	15.50	–	38.50	–	1 : 4.70	109.50	109.50	–

Total Amount of Feed consumed from Sept. 17, 1889, to March 17, 1890.

	Pounds.
68.62 pounds corn meal, equal to dry matter,	60.61
31.28 pounds gluten meal, equal to dry matter,	28.21
40.07 pounds wheat bran, equal to dry matter,	36.36
242.50 pounds rowen, equal to dry matter,	209.69
193.50 pounds corn ensilage, equal to dry matter,	52.34
43.50 pounds corn fodder, equal to dry matter,	34.40
Total amount of dry matter,	421.61

	Pounds.
Live weight of animal at beginning of experiment,	83.25
Live weight at time of killing,	109.50
Live weight gained during experiment,	26.25
Dressed weight at time of killing,	60.50
Loss in weight by dressing,	49 pounds, or 44.75 per cent.

Cost of Feed consumed during Experiment.

68.62 pounds corn meal, at $19.00 per ton,	$0 65
31.28 pounds gluten meal, at $23.00 per ton,	0 36
40.07 pounds wheat bran, at $17.00 per ton,	0 34
242.50 pounds rowen, at $15.00 per ton,	1 82
193.50 pounds corn ensilage, at $2.75 per ton,	0 27
43.50 pounds corn fodder, at $7.50 per ton,	0 17
	$3 61

16.06 pounds of dry matter fed yielded 1 pound of live weight.
Cost of feed for the production of 1 pound of live weight, 13.75 cents.

The composition of the fodder articles used during the experiment is the same as of those in preceding feeding records used during the corresponding months of the year.

Essential Fertilizing Constituents.

Nitrogen, 17 cents per pound; phosphoric acid, 6 cents; potassium oxide, 4½ cents.

	Wheat Bran.	Gluten Meal.	Rowen.	Corn Ensilage.	Corn Meal.	Corn Fodder.
Moisture at 100° C., .	9.27	9.80	13.53	72.95	88.33	20.42
Nitrogen, ...	2.545	4.510	1.790	0.33	1.479	1.058
Phosphoric acid, . .	2.900	0.392	0.351	0.138	0.713	0.510
Potassium oxide, . .	1.637	0.049	0.462	0.301	0.430	0.760
Valuation per ton, .	$13 60	$16 18	$6 92	$1 56	$6 27	$4 89

III. Feeding Experiments with Young Pigs.

1. General remarks on feeding experiments with young pigs, reported in the preceding report, 1889.
2. Feeding experiments with pigs, 1890. Medium Yorkshire.
3. Feeding experiments with pigs, 1890. Medium Yorkshire and grade Chester White.

1. Some General Remarks on raising Young Pigs for the Meat Market.

In planning our experiments for raising young pigs for the meat market, it was proposed at the outset (1884) to confine our inquiry, for the present, in particular to the following question : —

How can we most profitably dispose of two by-products of the dairy, — skim-milk and creamery buttermilk, — as a constituent of the daily diet of young pigs raised for the meat market?

From our preceding reports in this connection, it will be seen that we consider *two conditions* on farms, namely, a *large supply* of either home-made skim-milk or of creamery buttermilk, or a *limited one*, when making up the fodder combination for the daily diet of the animals on trial.

As the first requirement of an *economical* diet for any kind of farm live stock consists in a desirable nutritive character of the feed, suitable to the kind, the condition and the purpose of the animal on trial, it became our first aim to obtain, in all cases, as far as practicable, a corresponding nutritive character of the different fodder combinations to be used.

This circumstance was secured in the following way: whenever a liberal supply of either kind of waste milk was on hand, the subsequently first stated course of compounding the daily diet of the pigs was adopted; while, in case of a limited supply of either kind of milk, the second mode has been practiced, to provide for the increasing call for a suitable feed. In case of the use of grain feed, water has taken the place of milk for diffusing the latter when fed.

I.

Live Weight of Animal.	Corn Meal, Skim-milk.
20 to 70 pounds, . .	2 ounces for every quart of milk consumed.
70 to 130 pounds, . .	4 ounces for every quart of milk consumed.
130 to 200 pounds, . .	6 ounces for every quart of milk consumed.

II.

Live Weight of Animal.	Grain Mixture to Supplement Skim-milk and Corn Meal.		
	Gluten Meal. (Weight Parts.)	Wheat Bran. (Weight Parts.)	Corn Meal. (Weight Parts.)
20 to 70 pounds, . . .	2	1	–
70 to 130 pounds, . . .	1	1	1
130 to 200 pounds, . . .	1	1	2

Live Weight of Animal.	Nutritive Character of the Feed in Both Instances.
20 to 70 pounds,	1 digestible nitrogenous organic constituent. 2.8–3 non-nitrogenous organic constituents.
70 to 130 pounds,	1 digestible nitrogenous organic constituent. 3.6–4 non-nitrogenous organic constituents.
130 to 200 pounds,	1 digestible nitrogenous organic constituent. 4.5–5 non-nitrogenous organic constituents.

Our observations in this connection with the management of twelve feeding experiments, lead to the following suggestions regarding a proper course of raising pigs for the meat market: —

1. Begin as early as practicable, with a well-regulated system of feeding. During the moderate season, begin when the animals have reached from eighteen to twenty pounds in live weight; in the colder seasons, when they weigh from twenty-five to thirty pounds.

2. The feed for young pigs during their earlier stages of growth ought to be somewhat bulky, to promote the extension of their digestive organs, and to make them thereafter good eaters. A liberal supply of skim-milk or buttermilk,

with a periodical increase of corn meal, beginning with two ounces of corn meal per quart of milk, has given us highly satisfactory results.

3. Change the character of the diet, at certain stages of growth, from a rich nitrogenous diet to that of a wider ratio between the digestible nitrogenous and non-nitrogenous food constituents of the feed. Begin, for instance, with two ounces of corn meal to one quart of skim-milk; when the animal has reached from sixty to seventy pounds, use four ounces per quart; and feed six ounces of meal per quart after its live weight amounts to from one hundred and twenty to one hundred and thirty pounds. The superior feeding effect, noticed in case of one and the same diet during the earlier stages of growth, will not infrequently be found to decrease seriously during later stages.

4. It is not good economy to raise pigs for the meat market to an exceptionally high weight. To go beyond from one hundred and seventy-five to one hundred and eighty pounds is only advisable when exceptionally high market prices for dressed pork can be secured. The quality of the meat is also apt to be impaired by an increased deposition of fat. The power of assimilating food, and of converting it in an economical way into an increase of live weight, decreases with the progress of age.

5. It pays well, as far as the cost of feed is concerned, to protect the animals against the extremes of the season. Feeding experiments carried on during moderate seasons are more profitable than those carried on, under otherwise corresponding circumstances, during the winter season.

Our experiments previous to 1890 have been carried on with mixed breeds of a more or less doubtful parentage. Within the past year we began to compare thoroughbreds of distinct breeds with each other or with grades of known origin. The subsequent pages contain a description of two experiments, — one with medium Yorkshires, the other with medium Yorkshires and grade Chester Whites.

Another experiment with throughbreds — Berkshire, Tamworth, small Yorkshire and Poland China — is finished; the results will be published in connection with a second one of the same character as soon as the latter is closed.

Summary of Experiments I. to XII.

[Based on the same cost of feed and value of manurial refuse.]

EXPERIMENT.	Number of Pigs.	Average Weight of Pigs at Beginning of Experiment (Pounds).	Average Weight of Pigs at Close of Experiment (Pounds).	Articles of Fodder used.	Nutritive Ratio of Feed.	Pounds of Dry Matter consumed for the Production of One Pound of Dressed Pork.	Total Cost of Feed per Pound of Dressed Pork (Cents).	Manurial Value of Feed per Pound of Dressed Pork, after deducting Thirty Per Cent. taken by Pig (Cents).	Net Cost of Feed per Pound of Dressed Pork (Cents).
I. May 21 to Sept. 22, 1884, *a*,	3	48.8	239.0	Skim-milk, corn meal, .	1 : 2.50 to 1 : 2.97	2.50 to 3.11; average 2.90	5.15	1.70	3.45
I. May 21 to Sept. 22, 1884, *b*,	3	47.6	253.9	Buttermilk, corn meal, .	1 : 2.84 to 1 : 3.38	2.23 to 2.57; " 2.40	4.30	1.38	2.92
II. Nov. 5, 1884, to Mar. 21, 1885, *a*,	6	30.1	209.7	Buttermilk, corn meal, .	1 : 3.50 to 1 : 4.80	3.34 to 4.17; " 3.67	5.91	1.80	4.11
II. Nov. 5, 1884, to Mar. 21, 1885, *b*,	6	28.7	227.0	Skim-milk, corn meal, .	1 : 2.70 to 1 : 5.00	2.97 to 3.48; " 3.31	5.51	1.69	3.82
III. April 1 to Sept. 16, 1885, . .	2	49.8	276.3	Skim-milk, corn meal, . / Wheat bran, gluten meal,	1 : 3.04 to 1 : 3.76	4.01 to 4.18; " 4.10	6.41	2.01	4.40
IV. Dec. 8, 1885, to May 31, 1886, .	2	32.9	152.4	Skim-milk, corn meal, / Wheat bran, gluten meal,	1 : 2.64 to 1 : 4.48	3.77 to 4.08; " 3.93	6.33	2.13	4.20
V. Sept. 15, 1886, to Jan. 19, 1887, .	4	32.6	175.0	Skim milk, corn meal, . / Wheat bran, gluten meal,	1 : 2.75 to 1 : 3.57	3.56 to 4.31; " 3.92	5 40	2.02	3.38
VI. Feb. 17 to May 2, 1887, . . .	5	54.4	152.8	Skim-milk, corn meal, . / Wheat bran, gluten meal,	1 : 2.99 to 1 . 3.23	2.70 to 4.20; " 3 68	5.69	1.95	3.74
VII. June 28 to Oct. 26, 1887, . .	7	24.5	193.3	Skim-milk, corn meal, . / Wheat bran, gluten meal,	1 : 2.85 to 1 : 4.30	2.83 to 3.24; " 3.07	5.15	1.76	3.39
VIII. Nov. 8, 1887, to March 12, 1888, .	6	25.2	186.4	Skim-milk, corn meal, . / Wheat bran, gluten meal, / Corn and cob meal, . .	1 : 2.30 to 1 : 4.17	3.02 to 3.46; " 3.27	5.32	1.74	3.58
IX. April 12 to Aug. 8, 1888, . .	6	19.6	194.7	Skim-milk, corn meal, . / Wheat bran, gluten meal, / Corn and cob meal, . .	1 : 2.53 to 1 : 4.35	2.81 to 3.17; " 3.00	4.89	1.62	3.27
X. April 26 to Aug. 28, 1889, . .	7	20.3	189.9	Skim milk, barley meal, . / Wheat bran, gluten meal,	1 : 2.90 to 1 : 4.65	3.40 to 3.81; " 3.60	6.07	1.75	4.32
XI. Sept. 10, 1889, to March 3, 1890, .	5	20.8	189.5	Skim-milk, corn meal, . / Wheat bran, gluten meal,	1 : 2.99 to 1 : 4.36	3.80 to 3.99; " 3.89	6.11	1.98	4.13
XII. April 22 to Sept. 1, 1890, . .	4*	33.4	182.8	Skim-milk, . . .	1 : 2.80 to 1 : 4.25	" 4.07	5.90	1.99	3.91
	4†	30.5	190.2	Corn and cob meal, . / Wheat bran, gluten meal,	1 : 2.80 to 1 : 4.26	" 3.98	5.72	1.96	3.76

* Medium Yorkshires. † Grade Chester Whites.

The calculations included in the above summary were based upon the following valuations per ton: —

	Cost.	Manurial Value.
Corn meal,	$24 00	$7 97
Barley meal,	30 00	6 21
Skim-milk (10 per cent. solids),	1.8 cts. gal.	2 25
Buttermilk (7 to 8 per cent. solids),	1 37 " "	1 74
Corn and cob meal,	$20 70	6 06
Wheat bran,	22 50	13 51
Gluten meal,	22 50	17 49

2. *Eleventh Feeding Experiment with Pigs.*

Breed, medium Yorkshire; feed, skim-milk, corn meal, wheat bran and gluten meal; time, Sept. 10, 1889, to March 3, 1890.

Five pigs, sows, weighing at the beginning of the experiment from 18.5 to 21 pounds each, served for our observation. The systematic feeding began Sept. 10, 1889, and closed March 3, 1890, lasting thus 175 days. The live weight gained during that time varied in case of different animals from 160.75 to 178 pounds, with a daily average gain of .97 pound.

The daily consumption of skim-milk during the entire experiment was limited to 5 quarts per head, with the exception of the first ten days, when but 4 quarts were called for. Two ounces of corn meal were added to every quart of skim-milk consumed to complete the daily diet for that period. The additional supply of food needed in consequence of the growth of the animal was composed of a mixture of, —

I. { Wheat bran, one weight part.
{ Gluten meal, two weight parts.

beginning with a daily ration of the mixture of 6 ounces per head, and increasing the quantity gradually until it

reached to from 30 to 36 ounces. This point was obtained at the close of the second month of the observation, November 11. The live weights of the different animals varied at that time from 85 to 95 pounds. The nutritive ratio, *i. e.*, the relative proportion of the digestible nitrogen-containing organic constituents and non-nitrogen-containing organic constituents, calling the former one, in the daily fodder ration, remained practically the same during the first two months (1 : 3).

The composition of the grain feed was changed at the stated advance in the growth of the animal, while the daily quantity of skim-milk per head remained the same as before, — 5 quarts. The above specified grain mixture (I.) was simply replaced by the following, —

II. { Corn meal, four weight parts.
Wheat bran, one weight part.
Gluten meal, one weight part.

beginning with a daily average ration of 32 to 36 ounces per head, and closing with one of 42 to 45 ounces, December 30, when their respective live weights varied from 125 to 130 pounds.

The subsequent change in the composition of the daily diet consisted in an increase of the proportion of the corn meal in the daily grain feed. The daily quantity of skim-milk, 5 quarts, remained the same to the end of the experiment. An amount of water was added sufficient to satisfy the thirst of the animal. The new grain mixture (III.) consisted of, —

III. { Corn meal, six weight parts.
Wheat bran, one weight part.
Gluten meal, one weight part.

The amount consumed per day rose to 48 ounces per head in some instances, toward the close of the experiment.

The entire management of the feeding was divided, as will be noticed, into three periods, as far as the nutritive character of the daily diet was concerned : —

Periods.	Live Weight.	Nutritive Ratio.
I.,	20 to 90 pounds,	1 digestible nitrogenous organic constituent. 3 non-nitrogenous organic constituents.
II.,	90 to 130 pounds,	1 digestible nitrogenous organic constituent. 3 8 non-nitrogenous organic constituents.
III.,	130 to 200 pounds,	1 digestible nitrogenous organic constituent 4.25 non-nitrogenous organic constituents.

Conclusions deducted from the Results obtained.

1. The amount of dry organic matter contained in the feed consumed per pound of dressed pork secured varies in case of different animals from 3.80 to 3.99 pounds, the mean being 3.87 pounds.

2. The total cost of the feed consumed for the production of one pound of dressed pork secured varies in case of different animals from 5.43 to 5.72 cents, with a mean of 5.55 cents.

3. The total cost of the entire feed consumed during our late experiment XI. amounts to $39. The total market value of the entire amount of the essential fertilizing constituents contained in the feed consumed amounts at current market prices to $19.92. In making the customary liberal allowance of 30 per cent. for the loss sustained in nitrogen, phosphoric acid and potassium oxide, in consequence of the formation of flesh and bone in the growing animals, it will be noticed that the obtainable manurial value of the feed consumed amounts still to $13.94, which sum is fairly equal to one-third of the original cost of the entire feed used, or 1.98 cents per pound of dressed pork produced (702.75 pounds).

4. As the first cost of the feed consumed for the production of one pound of dressed pork amounted on an

average to 5.55 cents, and as the available manurial value of the feed for the same weight of dressed pork produced is equal to 1.98 cents, it will be seen that the average net cost of the feed consumed amounted to 3.57 cents per pound of dressed pork produced.

5. Comparing the financial results of the experiment here under discussion with those of an earlier experiment of ours (IV.), adopting for that purpose in both the same market price for the fodder articles consumed, and allowing at the same time a corresponding selling price for the dressed pork produced, no material difference can be pointed out. During our earlier experiment corn meal sold at $24 and wheat bran $22.50; during our previously described experiment corn meal sold at $19 and wheat bran at $16.50 per ton; skim-milk and gluten meal were charged alike in both experiments. In the earlier experiment the *net cost of the feed consumed* for the production of one pound of dressed pork was 4.20 cents, and in our recent experiment, as above stated, 3.57 cents. The difference of .63 cent in favor of the recent trial is essentially due to contemporary lower market prices of corn meal and wheat bran.

For further details, see statements upon a few subsequent pages.

Feeding Record of Pigs.

(1)

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
1889-1890.								
Sept. 10 to Sept. 30, . .	11.63	93.00	–	–	1:3.05	20.75	38.00	0.82
Oct. 1 to Nov. 11, . .	26.25	210.00	20.71	41.42	1:2.99	38.00	90.50	1.25
Nov. 12 to Dec. 30, . .	73.52	245.00	18.38	18.38	1:3.81	90.50	133.50	0.88
Dec. 31 to Mar. 3, . .	120.12	334.00	20.02	20.02	1:4.06	133.50	187.75	0.86

Total Amount of Feed consumed from Sept. 10, 1889, to March 3, 1890.

	Pounds.
231.52 pounds corn meal, equal to dry matter,	204.50
882.00 quarts skim-milk, equal to dry matter,	195.60
59 11 pounds wheat bran, equal to dry matter,	53.63
79.82 pounds gluten meal, equal to dry matter,	72.00
Total amount of dry matter,	525.73

	Pounds.
Live weight of animal at beginning of experiment,	20.75
Live weight at time of killing,	187.75
Live weight gained during experiment,	167.00
Dressed weight at time of killing,	155.50
Loss in weight by dressing,	32.25 pounds, or 17.18 per cent.
Dressed weight gained during experiment,	138.50

Cost of Feed consumed during Experiment.

231.52 pounds corn meal, at $19.00 per ton,	$2 20
220.50 gallons skim-milk, at 1.8 cents per gallon,	3 97
59.11 pounds wheat bran, at $16.50 per ton,	0 49
79.82 pounds gluten meal, at $23.00 per ton,	0 92
	$7 58

3.15 pounds of dry matter fed yielded 1 pound of live weight, and 3.80 pounds of dry matter yielded 1 pound of dressed weight.

Total cost of feed for the production of 1 pound of dressed pork, 5.47 cents.

Net cost of feed for the production of 1 pound of dressed pork, 3.49 cents.

(2)

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds)	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
1889-1890.								
Sept. 10 to Sept. 30,	11.63	93.00	-	-	1:3.05	19.00	37.00	0.86
Oct. 1 to Nov. 11,	26.25	210.00	22.46	44.92	1:2.99	37.00	93.75	1.35
Nov. 12 to Dec. 30,	68.48	245.00	17.12	17.12	1:3.74	93.75	127.00	0.68
Dec. 31 to Mar. 3,	156.36	334.00	26.06	26.06	1:4.36	127.00	197.25	1.12

Total Amount of Feed consumed from Sept. 10, 1889, to March 3, 1890.

	Pounds.
262.72 pounds corn meal, equal to dry matter,	232.06
882.00 quarts skim-milk, equal to dry matter,	195.60
65 64 pounds wheat bran, equal to dry matter,	59.56
88.10 pounds gluten meal, equal to dry matter,	79.47
Total amount of dry matter,	566.69

	Pounds.
Live weight of animal at beginning of experiment,	19.00
Live weight at time of killing,	197.25
Live weight gained during experiment,	178.25
Dressed weight at time of killing,	163.50
Loss in weight by dressing, 33.75 pounds, or 17.11 per cent.	
Dressed weight gained during experiment,	147.75

Cost of Feed consumed during Experiment.

262.72 pounds corn meal, at $19.00 per ton,	$2 50
220.50 gallons skim-milk, at 1.8 cents per gallon,	3 97
65.64 pounds wheat bran, at $16.50 per ton,	0 54
88.10 pounds gluten meal, at $23.00 per ton,	1 01
	$8 02

3.18 pounds of dry matter fed yielded 1 pound of live weight, and 3.84 pounds of dry matter yielded 1 pound of dressed weight.

Total cost of feed for the production of 1 pound of dressed pork, 5.43 cents.

Net cost of feed for the production of 1 pound of dressed pork, 3.45 cents.

(3)

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-Milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
1889-1890.								
Sept. 10 to Sept. 30,	11.63	93.00	–	–	1 : 3.05	24.25	41.75	0.83
Oct. 1 to Nov. 11,	26.25	210.00	22.08	44.16	1 : 2.99	41.75	92.75	1.21
Nov. 12 to Dec. 23,	83.48	210.00	20.87	20.87	1 : 4.08	92.75	136.50	1.04
Dec. 24 to Mar. 3,	153.30	369.00	25.55	25.55	1 : 4.23	136.50	199.00	0.89

Total Amount of Feed consumed from Sept. 10, 1889, to March 3, 1890.

	Pounds.
274.66 pounds corn meal, equal to dry matter,	242.61
882.00 quarts skim-milk, equal to dry matter,	195.60
68.50 pounds wheat bran, equal to dry matter,	62.15
90.58 pounds gluten meal, equal to dry matter,	81.70
Total amount of dry matter,	582.06

	Pounds.
Live weight of animal at beginning of experiment,	24.25
Live weight at time of killing,	199.00
Live weight gained during experiment,	174.75
Dressed weight at time of killing,	167.00
Loss in weight by dressing,	32.00 pounds, or 16.08 per cent.
Dressed weight gained during experiment,	146.75

Cost of Feed consumed during Experiment.

274.66 pounds corn meal, at $19.00 per ton,	$2 61
220.50 gallons skim-milk, at 1.8 cents per gallon,	3 67
68.50 pounds wheat bran, at $16.50 per ton,	0 57
90.58 pounds gluten meal, at $23.00 per ton,	1 04
	$8 19

3.33 pounds of dry matter fed yielded 1 pound of live weight, and 3.97 pounds of dry matter yielded 1 pound of dressed weight.

Total cost of feed for the production of 1 pound of dressed pork, 5.58 cents.

Net cost of feed for the production of 1 pound of dressed pork, 3.60 cents.

(4)

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
1889-1890.								
Sept. 10 to Sept. 30,	11.63	93.00	-	-	1 : 3.05	21.25	38.00	0.80
Oct. 1 to Nov. 11,	26.25	210.00	22.46	44.92	1 : 2.99	38.00	90.25	1.24
Nov. 12 to Dec. 23,	79.12	210.00	19.78	19.78	1 : 4.03	90.25	132.00	0.99
Dec. 24 to Mar. 3,	118.68	369.00	19.78	19.78	1 : 3.94	132.00	184.00	0.74

Total Amount of Feed consumed from Sept. 10, 1889, to March 3, 1890.

	Pounds.
235.68 pounds corn meal, equal to dry matter,	208.18
882.00 quarts skim-milk, equal to dry matter,	195.60
62.02 pounds wheat bran, equal to dry matter,	56.09
84.48 pounds gluten meal, equal to dry matter,	76.20
Total amount of dry matter,	536.07

	Pounds.
Live weight of animal at beginning of experiment,	21.25
Live weight at time of killing,	184.00
Live weight gained during experiment,	162.75
Dressed weight at time of killing,	152.00
Loss in weight by dressing,	32.00 pounds, or 17.39 per cent.
Dressed weight gained during experiment,	134.50

Cost of Feed consumed during Experiment.

235.68 pounds corn meal, at $19.00 per ton,	$2 24
220.50 gallons skim-milk, at 1.8 cents per gallon,	3 97
62.02 pounds wheat bran, at $16.50 per ton,	0 51
84.48 pounds gluten meal, at $23.00 per ton,	0 97
	$7 69

3.29 pounds of dry matter fed yielded 1 pound of live weight, and 3.99 pounds of dry matter yielded 1 pound of dressed weight.

Total cost of feed for the production of 1 pound of dressed pork, 5.72 cents.

Net cost of feed for the production of 1 pound of dressed pork, 3.74 cents.

(5)

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
1889-1890.								
Sept. 10 to Sept. 30,	11.63	93.00	–	–	1:3.05	18.75	35.75	0.81
Oct. 1 to Nov. 11,	26.25	210.00	20.08	40.16	1:2.98	35.75	83.50	1.14
Nov. 12 to Jan. 6,	68.25	280.00	17.06	17.06	1:3.61	83.50	128.00	0.80
Jan. 7 to Mar. 3,	124.14	299.00	20.69	20.69	1:4.23	128.00	179.50	0.92

Total Amount of Feed consumed from Sept. 10, 1889, to March 3, 1890.

	Pounds.
230.27 pounds corn meal, equal to dry matter,	203.40
882.00 quarts skim-milk, equal to dry matter,	195.60
57.83 pounds wheat bran, equal to dry matter,	52.47
77.91 pounds gluten meal, equal to dry matter,	70.27
Total amount of dry matter,	521.74

	Pounds.
Live weight of animal at beginning of experiment,	18.75
Live weight at time of killing,	179.50
Live weight gained during experiment,	160.75
Dressed weight at time of killing,	151.00
Loss in weight by dressing,	28.50 pounds, or 15.87 per cent.
Dressed weight gained during experiment,	135.25

Cost of Feed consumed during Experiment.

230.27 pounds corn meal, at $19.00 per ton,	$2 19
220.50 gallons skim-milk, at 1.8 cents per gallon,	3 97
57.83 pounds wheat bran, at $16.50 per ton,	0 48
77.91 pounds gluten meal, at $23.00 per ton,	0 90
	$7 54

3.25 pounds of dry matter fed yielded 1 pound of live weight, and 3.86 pounds of dry matter yielded 1 pound of dressed weight.

Total cost of feed for the production of 1 pound of dressed pork, 5.57 cents.

Net cost of feed for the production of 1 pound of dressed pork, 3.59 cents.

Summary of Experiment XI.

	Corn Meal (Pounds).	Skim-milk (Gallons).	Wheat Bran (Pounds).	Gluten Meal (Pounds).	Live Weight gained during Experiment (Pounds).	Dressed Weight gained during Experiment (Pounds).	Cost per Pound of Dressed Pork (Cents).
Pig No. 1,	231.52	220.5	59.11	79.82	167.00	138.50	5.47
Pig No. 2,	262.72	220.5	65.64	88.10	178.25	147.75	5.43
Pig No. 3,	274.66	220.5	68.50	90.58	174.75	146.75	5.58
Pig No. 4,	235.68	220.5	62.02	84.48	162.75	134.50	5.72
Pig No. 5,	230.27	220.5	57.83	77.91	160.75	135.25	5.57
Total,	1,234.85	1,102.5	313.10	420.89	843.50	702.75	–

Total Cost of Feed consumed during Experiment.

1,102 50 gallons skim-milk, at 1.8 cents per gallon,	$19 85
1,234.85 pounds corn meal, at $19.00 per ton,	11 73
313.10 pounds wheat bran, at $16.50 per ton,	2 58
420 89 pounds gluten meal, at $23.00 per ton,	4 84
	$39 00

Average cost of feed for production of 1 pound of dressed pork, 5.55 cents.

Average net cost of feed for production of 1 pound of dressed pork, after deducting the manurial value less 30 per cent., 3.57 cents.

Valuation of Essential Fertilizing Constituents in the Various Articles of Fodder used.

Nitrogen, 17 cents per pound; phosphoric acid, 6 cents; potassium oxide, 4½ cents.

	Corn Meal.	Skim-milk	Wheat Bran.	Gluten Meal.
Moisture at 100° C.,	11.67	89.78	9.27	9.80
Nitrogen,	1.479	0.52	2.545	4.510
Phosphoric acid,	0.713	0.19	2.900	0.392
Potassium oxide,	0.430	0.20	1.637	0.049
Valuation per 2,000 pounds,	$6 27	$2 18	$14 59	$15 85

Manurial Value of Feed consumed during Experiment.

Corn Meal.	Skim-milk.	Wheat Bran.	Gluten Meal.	Total.
$3 87	$10 43	$2 28	$3 34	$19 92

The manurial value of feed for the production of 1 pound of dressed pork is 2 83 cents; after the deduction of 30 per cent., 1.98 cents.

Composition of Fodder Articles fed during the Previously Described Experiment

Skim-milk (Average).

[One quart = 2.17 pounds.]

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	89.78	1,795.60	–	–	
Dry matter,	10.22	204.40	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	6.85	137.00	–	–	
" cellulose,	–	–	–	–	1 : 2.13
" fat,	3.82	76.40	76.40	100	
" protein (nitrogenous matter),	31.60	632.00	632.00	100	
Non-nitrogenous extract matter,	57.73	1,155.60	1,155.60	100	
	100.00	2,000.00	1,864.00	–	

Gluten Meal.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	9.80	196.00	–	–	
Dry matter,	90.20	1,804.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	1.25	25.00	–	–	
" cellulose,	1.75	35.00	11.90	34	1 : 2.60
" fat,	7.00	140.00	106.40	76	
" protein (nitrogenous matter),	31.25	625.00	531.25	85	
Non-nitrogenous extract matter,	58.75	1,175.00	1,104.50	94	
	100.00	2,000.00	1,754.05	–	

For analyses of corn meal and wheat bran used in this experiment, see winter cow feeding experiment.

3. Twelfth Feeding Experiment with Pigs.

Breed, medium Yorkshire, grade Chester White; feed, skim-milk, corn and cob meal, wheat bran, gluten meal; time, April 22 to Sept. 1, 1890.

Eight pigs, four medium Yorkshires and four grade Chester Whites, were secured for the trial. Each lot consisted of two sows and two barrows. The individual live weight of the medium Yorkshires varied from 30 to 37 pounds, and that of the grade Chester Whites from 28.75 to 33 pounds, at the beginning of the observation. The feeding began April 22 and closed September 1, thus covering a period of 133 days.

The general course pursued in the management of the experiment is materially the same as adopted in the preceding VII., VIII., IX., X., XI. The main alteration consists in the substitution of corn and cob meal in place of the corn meal. The amount of skim-milk consumed daily per head remained practically the same, after the first week, — four quarts. To every quart of milk required were added two ounces of corn and cob meal. The additional feed subsequently needed consisted of a mixture of two weight parts of gluten meal and one of wheat bran. At the close of the second month of our trial, when the live weights of the various animals amounted to from 120 to 130 pounds each, the diet was changed; a mixture of four weight parts of corn and cob meal and one weight part each of gluten meal and wheat bran was fed with the original quantity of skim-milk, — four quarts daily per head. The subsequent tabular statement shows the changes in the nutritive character of the feed at different stages of growth. The entire experiment might be divided practically into three feeding periods: —

	Live Weight.	Nutritive Ratio.
Period I., ...	20 to 90 pounds.	1 : 2.83
Period II., ...	90 to 130 pounds.	1 : 3.60
Period III.,.	130 to 200 pounds.	1 : 4.25

The live weight gained during the experiment amounted in the case of the four medium Yorkshires to 596 pounds, and in the case of the four grade Chester Whites to 640 pounds, showing an increase of 44 pounds in favor of the latter.

Medium Yorkshires.

	Pounds.		Pounds.
1. Sow, live weight at beginning, .	37.00	Live weight at close,	174.5
2. Barrow, live weight at beginning,	32.25	Live weight at close,	197.0
3. Sow, live weight at beginning, .	30.00	Live weight at close,	163.0
4. Barrow, live weight at beginning,	34.25	Live weight at close,	195.0
	133.50		729.5

Grade Chester Whites.

	Pounds.		Pounds.
1. Sow, live weight at beginning, .	31.25	Live weight at close,	207.0
2. Sow, live weight at beginning, .	33.00	Live weight at close,	177.5
3. Barrow, live weight at beginning,	29.00	Live weight at close,	199.0
4. Barrow, live weight at beginning,	28.75	Live weight at close,	178.5
	122.00		762.0

The live weight gained during the experiment varied, as will be noticed from the preceding detailed record in case of different animals of medium Yorkshires from 133 to 164.75 pounds, and in case of grade Chester Whites from 144.5 to 175.75 pounds. Considering in both cases the entire lot, the average gain in live weight per head is 149 pounds in case of the medium Yorkshires, and 160 pounds in that of grade Chester Whites. This difference in the live weights of both lots disappears in the weights of the dressed pork.

Medium Yorkshires.

	Pounds.
1. Dressed weight, ...	134
2. Dressed weight, ...	158
3. Dressed weight, ...	130
4. Dressed weight, ...	157
Total, ...	579

Grade Chester Whites.

	Pounds.
1. Dressed weight, ...	160
2. Dressed weight, ...	128
3. Dressed weight, ...	151
4. Dressed weight, ...	138
Total, ...	577

The shrinkage of the medium Yorkshires was equal to 21 per cent., and that of the grade Chester Whites 24 per cent., of their live weights. The large percentage of shrinkage is mainly due to the fact that by some oversight the animals had been fed once on the day of killing. The medium Yorkshires lead the grade Chester Whites by two pounds in dressed weight, making the result an exceptionally close one.

Four and seven-hundredths pounds of dry matter in the feed produced one pound of dressed pork in the case of the medium Yorkshires, while 3.98 pounds of dry matter in the feed produced one pound of dressed pork in case of grade Chester Whites.

The market cost of feed consumed for the production of one pound of dressed pork was 5.60 cents in the case of medium Yorkshires, and 5.45 cents in that of the grade Chester Whites. The market cost of the feed consumed is $26.51 in the case of the medium Yorkshires, and in that of the grade Chester Whites it is $26.41.

The manurial value of the nitrogen, phosphoric acid and potassium oxide contained in the feed consumed is in the first-named instance equal to $13.46, and in the latter $13.59. Allowing 30 per cent. of the stated essential fertilizing constituents as retained in the organization of the growing animal and thus lost, there remain 70 per cent. of them obtainable in the manure. The obtainable portion of the manurial constituents of the feed is worth $9.42 in the case of the medium Yorkshires, and $9.51 in that of the grade Chester Whites, making the net cost of feed in the first-named lot $17.09, and in the second lot $16.90.

The net cost of the feed consumed for the production of one pound of dressed pork is 3.61 cents in the case of the medium Yorkshires, and 3.49 cents in that of the grade Chester Whites, — a difference of .12 cent per pound in favor of the latter.

Medium Yorkshires (Four Pigs).

FEEDING PERIODS.	Total Amount of Corn and Cob Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day during Period (Pounds).
1890.								
April 22 to June 2, .	88.69	713.50	35.94	71.88	1:2.83	133.50	286.00	3.54
June 3 to July 21, .	351.56	882.00	131.06	131.06	1:3.68	286.00	515.75	4.69
July 22 to Sept. 8, . .	532.51	876.00	114.40	114.40	1:4.25	515.75	729.50	4.36

Total Amount of Feed consumed from April 22 to Sept. 8, 1890.

	Pounds.
972.76 pounds corn and cob meal, equal to dry matter, . .	836.28
2,471.50 quarts skim-milk, equal to dry matter, . . .	548.11
281.40 pounds wheat bran, equal to dry matter, . . .	248.98
317.34 pounds gluten meal, equal to dry matter, . . .	290.43
Total amount of dry matter, ...	1,923.80

	Pounds.
Aggregate live weight of animals at beginning of experiment,	133.50
Aggregate live weight at time of killing, ...	729.50
Live weight gained during experiment, ...	596.00
Dressed weight at time of killing, ...	579.00
Loss in weight by dressing, . . . 20.63 per cent., or	150.50
Dressed weight gained during experiment, ...	473.04

Cost of Feed consumed during Experiment.

972.76 pounds corn and cob meal, at $18.00 per ton, . .	$8 75
617.88 gallons skim-milk, at 1.8 cents per gallon, . . .	11 12
281.40 pounds wheat bran, at $19.00 per ton, ...	2 67
317.34 pounds gluten meal, at $25.00 per ton, ...	3 97
	$26 51

3.23 pounds of dry matter fed yielded 1 pound of live weight, and 4.07 pounds of dry matter yielded 1 pound of dressed weight.

Cost of feed for the production of 1 pound of dressed pork at stated market prices, 5.60 cents.

Net cost per pound of dressed pork produced, 3.61 cents.

Grade Chester Whites (Four Pigs).

FEEDING PERIODS.	Total Amount of Corn and Cob Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day during Period (Pounds).
1890.								
April 22 to June 2, .	90.25	728.00	46.21	92.42	1:2.81	122.00	312.00	4.52
June 3 to July 21, .	353.94	882.00	133.44	133.44	1:3.68	312.00	541.00	4.67
July 22 to Sept. 1, .	504.47	750.00	123.99	123.99	1:4.26	541.00	762.00	5.26

Total Amount of Feed consumed from April 22 to Sept. 1, 1890.

	Pounds.
948.66 pounds corn and cob meal, equal to dry matter, . .	815.56
2,360.00 quarts skim-milk, equal to dry matter, . . .	523.39
303.63 pounds wheat bran, equal to dry matter, . . .	268.65
349.85 pounds gluten meal, equal to dry matter, . . .	320.18
Total amount of dry matter, ...	1,927.78

	Pounds.
Aggregate live weight of animals at beginning of experiment,	122.00
Aggregate live weight at time of killing, ...	762.00
Live weight gained during experiment, ...	640.00
Dressed weight at time of killing, ...	577.00
Loss in weight by dressing, . . . 24.28 per cent, or	185.00
Dressed weight gained during experiment, ...	484.62

Cost of Feed consumed during Experiment.

948.66 pounds corn and cob meal, at $18.00 per ton, . .	$8 54
590.00 gallons skim-milk, at 1.8 cents per gallon, . .	10 62
303.63 pounds wheat bran, at $19.00 per ton, ...	2 88
349.85 pounds gluten meal, at $25.00 per ton, ...	4 37
	$26 41

3.01 pounds of dry matter fed yielded 1 pound of live weight, and 3.98 pounds of dry matter yielded 1 pound of dressed weight.

Cost of feed for the production of 1 pound of dressed pork at stated market prices, 5.45 cents.

Net cost per pound of dressed pork produced, 3.49 cents.

Valuation of Essential Fertilizing Constituents in the Various Fodder Articles used.

Nitrogen, 17 cents per pound; phosphoric acid, 6 cents; potassium oxide, 4½ cents.

	Corn and Cob Meal.	Skim-milk.	Wheat Bran.	Gluten Meal.
Moisture at 100° C.,	14.03	89.78	11.52	8.48
Nitrogen,	1.279	0.520	2.600	5.358
Phosphoric acid,	0.576	0.190	2.870	0.425
Potassium oxide,	0.440	0.200	1.620	0.045
Valuation per 2,000 pounds,	$5 43	$2 18	$13 74	$19 13

Manurial Value of the Feed.

	Grade Chester Whites.	Medium Yorkshires.
Corn and cob meal,	$2 58	$2 65
Skim-milk,	5 58	5 85
Wheat bran,	2 09	1 93
Gluten meal,	3 34	3 03
	$13 59	$13 46

Composition of Fodder Articles fed during the Previously Described Experiment.

Corn and Cob Meal.

	Per Cent.
Moisture at 100° C.,	14.03
Dry matter,	85.97
	100.00

Analysis of Dry Matter.

Crude ash,	1.74
" cellulose,	3.96
" fat,	3.59
" protein (nitrogenous matter),	9.30
Non-nitrogenous extract matter,	81.41
	100.00

Corn Meal (Average).

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	12 39	247 80	–	–	
Dry matter,	87.61	1,752.20	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	1.80	36.00	–	–	
" cellulose,	1.80	36.00	12.24	34	1 : 9.70
" fat,	5.01	100.20	76.15	76	
" protein (nitrogenous matter),	10.46	209.20	177.82	85	
Non-nitrogenous extract matter,	80.93	1,618 60	1,521.48	94	
	100.00	2,000.00	1,787.69	–	

Skim-milk, same as in pig feeding experiment XI.

Wheat bran, same as in summer cow feeding experiment.

IV. Fodder Analyses. (1890.)

The majority of the analyses stated under the above heading are made of fodder articles which have been used either during the past year in connection with some of our feeding experiments, or have been raised upon the grounds of the station. Some articles sent on by outside parties are added, on account of the special interest they may present to others.

In presenting these analyses, it seems but proper to call the attention of farmers once more forcibly to a careful consideration of the following facts.

The composition of the various articles of food used in farm practice exerts a decided influence on the manurial value of the animal excretions, resulting from their use in the diet of different kinds of farm live stock. The more potash, phosphoric acid, and, in particular, nitrogen, a fodder contains, the more valuable will be, under otherwise corresponding circumstances, the manurial residue left behind after it has served its purpose as a constituent of the food consumed.

As the financial success in a mixed farm management depends, in a considerable degree, on the amount, the character and the cost of the manurial refuse material secured in connection with the special farm industry carried on, it needs no further argument to prove that the relations which exist between the composition of the fodder and the value of the manure resulting deserve the careful consideration of the farmer, when devising an efficient and at the same time an economical diet for his live stock.

The higher or lower commercial value of the manurial refuse left behind after the feed has accomplished its purpose in a satisfactory degree, decides its actual or net cost in farm industry. A disregard of this circumstance renders, in many instances, a remunerative dairying not less doubtful than a profitable feeding of live stock for the meat market.

Corn Meal.

[Amherst Mill.]

84.98 per cent. passed screen 144 meshes to square inch.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	13 00	260.00	–	–	
Dry matter,	87.00	1,740.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	1 10	22.00	–	–	
" cellulose,	2.09	41 80	14.21	34	1 : 9.94
" fat,	4.95	99.00	75.24	76	
" protein (nitrogenous matter),	10.27	205 40	174.59	85	
Non-nitrogenous extract matter,	81.59	1,631.80	1,533 89	94	
	100 00	2,000.00	1,797.93	–	

Corn and Cob Meal.

[Amherst Mill.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	8.10	14.03
Dry matter,	91.90	85.97
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	1.47	1.74
" cellulose,	5.63	3.96
" fat,	3.73	3.59
" protein (nitrogenous matter),	9.79	9.30
Non-nitrogenous extract matter,	79.38	81.41
	100.00	100.00
Passed screen 144 meshes to square inch,	76.34	72.48

Corn Meal.

[Amherst Mill]

87.90 per cent. passed screen 144 meshes to square inch.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	13.64	272.80	–	–	
Dry matter,	86.36	1,727.20	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	2.52	50.40	–	–	
" cellulose,	1.78	35.60	12.10	34	1 : 9.95
" fat,	4.83	96.60	73.42	76	
" protein (nitrogenous matter),	10.13	202.60	172.21	85	
Non-nitrogenous extract matter,	80.74	1,614.80	1,517.91	94	
	100.00	2,000.00	1,775.64	–	

Corn Meal.

[Amherst Mill.]

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	12.39	247.80	–	–	
Dry matter,	87.61	1,752.20	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	1.80	36.00	–	–	
" cellulose,	1.80	36.00	12.24	34	1 : 9.30
" fat,	5.01	100.20	76.15	76	
" protein (nitrogenous matter),	10.46	209.20	177.82	85	
Non-nitrogenous extract matter,	80.93	1,618.60	1,521.48	94	
	100.00	2,000.00	1,787.69	–	

Corn Meal.

[Sent on from Bolton, Mass.]

	Per Cent.		
	Cob Meal.	Corn Meal.	Corn Meal.
Moisture at 100° C.,	16.09	16.00	16.13
Dry matter,	83.91	84.00	83.87
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	2.50	1.82	1.99
" cellulose,	5.71	1.24	1.55
" fat,	4.48	4.21	5.00
" protein (nitrogenous matter),	9.69	11.01	10.43
Non-nitrogenous extract matter,	77.62	81.72	81.03
	100.00	100.00	100.00
Passed screen 144 meshes to square inch,	60.50	89.91	82.64

Corn Meal.

[Two samples, sent on by Geo. C. Fitch, East Amherst, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C,	13.92	14.53
Dry matter,	86.08	85.47
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	1.59	1.66
" cellulose,	1.93	1.44
" fat,	4.95	4.84
" protein (nitrogenous matter),	9.73	10.16
Non-nitrogenous extract matter,	81.80	81.90
	100.00	100.00
Passed screen 144 meshes to square inch,	90.48	73.50

Wheat Bran.

[Amherst Mill.]

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	9.69	193.80	–	–	
Dry matter,	90.31	1,806.20	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					1 : 3.68
Crude ash,	7.40	148.00	–	–	
" cellulose,	9.86	197.20	39.44	20	
" fat,	5.81	116.20	92.96	80	
" protein (nitrogenous matter),	18.60	372.00	327.36	88	
Non-nitrogenous extract matter,	58.33	1,166.60	933.28	80	
	100.00	2,000.00	1,393.04	–	

Wheat Bran.

[Amherst Mill.]

47.64 per cent. passed screen 144 meshes to square inch.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	10.14	202.80	–	–	
Dry matter,	89.86	1,797.20	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					1 : 3.73
Crude ash,	7.11	142.20	–	–	
" cellulose,	10.57	211.40	42.28	20	
" fat,	5.38	107.60	86.08	80	
" protein (nitrogenous matter),	18.23	364.60	320.85	88	
Non-nitrogenous extract matter,	58.71	1,174.20	939.36	80	
	100.00	2,000.00	1,388.57	–	

Wheat Bran.

[Amherst Mill.]

48.85 per cent. passed screen 144 meshes to square inch.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	11 52	230.40	–	–	
Dry matter,	88.48	1,769.60	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	7.13	142 60	–	–	
" cellulose,	10.63	212 60	42.52	20	1 : 3.70
" fat,	5.62	112.40	89.92	80	
" protein (nitrogenous matter),	18.36	367.20	323.14	88	
Non-nitrogenous extract matter,	58.26	1,165 20	932 16	80	
	100.00	2,000.00	1,387.74	–	

Wheat Bran.

[Amherst Mill.]

20.04 per cent. passed screen 144 meshes to square inch.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	12.69	253.80	–	–	
Dry matter,	87.31	1,746.20	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	7 06	141.20	–	–	
" cellulose,	14.01	280.20	56.04	20	1 : 3.38
" fat,	5.47	109.40	87.52	80	
" protein (nitrogenous matter),	19.19	383.80	337.74	88	
Non-nitrogenous extract matter,	54.27	1,085.40	868.32	80	
	100.00	2,000.00	1,349.62	–	

Wheat Shorts.

[Two samples, sent on by C. A. Newhall, Lynn, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	8.87	10.33
Dry matter,	91.13	89.67
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	7.14	7.96
" cellulose,	8.58	11.21
" fat,	5.86	5.52
" protein (nitrogenous matter),	16.71	17.28
Non-nitrogenous extract matter,	61.71	58.03
	100.00	100.00
Passed screen 144 meshes to square inch,	52.60	55.00

Wheat Shorts.

[Sent on by W. F. Williams, South Amherst, Mass.]

	Per Cent	
	Winter Bran.	Summer Bran.
Moisture at 100° C.,	7.42	7.87
Dry matter,	92.58	92.13
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	7.19	6.82
" cellulose,	8.01	9.87
" fat,	5.75	5.86
" protein (nitrogenous matter),	18.09	17.77
Non-nitrogenous extract matter,	60.96	59.68
	100.00	100.00
Passed screen 144 meshes to square inch,	60.40	61.20

Old-process Linseed Meal.

76.40 per cent. passed screen 144 meshes to square inch.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	8 72	174.40	–	–	
Dry matter,	91.28	1,825.60	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	5 96	119.20	–	–	
" cellulose,	8 23	164.60	42 79	26	1: 1.93
" fat,	9.87	197.40	179.63	91	
" protein (nitrogenous matter),	36.19	723.80	629.70	87	
Non-nitrogenous extract matter,	39.75	795.00	723.45	91	
	100.00	2,000.00	1,575.57	–	

Fertilizing Constituents of Old-process Linseed Meal.

	Per Cent.
Moisture at 100° C.,	8.72
Ash,	5.44
Calcium oxide,	0.68
Magnesium oxide,	0.69
Sodium oxide,	0.86
Ferric oxide,	0.05
Potassium oxide (4¼ cents per pound),	1.37
Phosphoric acid (6 cents per pound),	2.17
Nitrogen (17 cents per pound),	5.29
Insoluble matter,	0.31
Valuation per ton,	$21 75

Old-process Linseed Meal.

87.40 per cent. passed screen 144 meshes to square inch.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	9.30	186.00	–	–	
Dry matter,	90.70	1,814.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	7.70	154.00	–	–	
" cellulose,	8.96	179.20	46.59	26	1 : 1.78
" fat,	6.50	130.00	118.30	91	
" protein (nitrogenous matter),	35.27	705.40	613.09	87	
Non-nitrogenous extract matter,	41.57	831.40	756.57	91	
	100.00	2,000.00	1,534.55	–	

Old-process Linseed Meal.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	11.50	230.00	–	–	
Dry matter,	88.50	1,770.00	–	–	
	100.00	2,000 00	–	–	
Analysis of Dry Matter.					
Crude ash,	6.08	121.60	–	–	
" cellulose,	8.64	172.80	44.93	26	1 : 1.50
" fat,	6.43	128.60	117.03	91	
" protein (nitrogenous matter),	39.97	799.40	695.48	87	
Non-nitrogenous extract matter,	38.88	777.60	707.62	91	
	100.00	2,000.00	1,565.06	–	

New-process Linseed Meal.

58.84 per cent. passed screen 144 meshes to square inch.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	5.06	101.20	–	–	
Dry matter,	94.94	1,898.80	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	6.34	126.80	–	–	
" cellulose,	8.93	178.60	46.43	26	1 : 1.26
" fat,	2.17	43.40	39.49	91	
" protein (nitrogenous matter),	41.02	820.40	713.74	87	
Non-nitrogenous extract matter,	41.54	830.80	756.02	91	
	100.00	2,000.00	1,555.68	–	

New-process Linseed Meal.

47.35 per cent. passed screen 144 meshes to square inch.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	11.83	236.60	–	–	
Dry matter,	88.17	1,763.40	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	6.43	128.60	–	–	
" cellulose,	9.01	180.20	48.65	26	1 : 1.376
" fat,	3.15	63.00	57.33	91	
" protein (nitrogenous matter),	39.91	798.20	694.43	87	
Non-nitrogenous extract matter,	41.50	830.00	755.30	91	
	100.00	2,000.00	1,555.71	–	

New-process Linseed Meal.

55.60 per cent. passed screen 144 meshes to square inch.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	8.29	165.80	–	–	
Dry matter,	91.71	1,834.20	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	5.91	118.20	–	–	
" cellulose,	9.43	188.60	49.04	26	1 : 1.74
" fat,	4.08	81.60	74.26	91	
" protein (nitrogenous matter),	35.03	700.60	609.51	87	
Non-nitrogenous extract matter,	45.55	911.00	829.01	91	
	100.00	2,000.00	1,561.82	–	

Fertilizing Constituents of New-process Linseed Meal.

	Per Cent.
Moisture at 100° C.,	8.29
Ash,	5.42
Calcium oxide,	0.96
Magnesium oxide,	0.63
Ferric oxide,	0.06
Potassium oxide (4¼ cents per pound),	1.57
Phosphoric acid (6 cents per pound),	1.80
Nitrogen (17 cents per pound),	5.14
Insoluble matter,	0.17
Valuation per ton,	$20 97

Cotton-seed Meal.

[Sent on by E. H. McIntosh, Needham, Mass.]

	Per Cent.
Moisture at 100° C.,	10.50
Dry matter,	89.50
	100.00
Analysis of Dry Matter.	
Crude ash,	8.47
" cellulose,	10.40
" fat,	9.57
" protein (nitrogenous matter),	46.92
Non-nitrogenous extract matter,	24.64
	100.00
Passed screen 144 meshes to square inch,	66.24

Fertilizing Constituents of Cotton-seed Meal.

	Per Cent.
Moisture at 100° C.,	10.500
Calcium oxide,	0.295
Magnesium oxide,	0.721
Sodium oxide,	0.249
Potassium oxide,	1.830
Nitrogen,	6.720
Phosphoric acid,	2.350
Insoluble matter,	0.390

Sea Island Cotton-seed Meal (Ground with Hulls on).

[Sent on by Butler, Breed & Co., Boston, Mass.]

	Per Cent.
Moisture at 100° C.,	11.62
Dry matter,	88.38
	100.00

Analysis of Dry Matter.

Crude ash,	12.07
" cellulose,	20.04
" fat,	8.90
" protein (nitrogenous matter),	26.07
Non-nitrogenous extract matter,	32.92
	100.00
Passed screen 144 meshes to square inch,	52.72

Fertilizing Constituents of the Above.

	Per Cent.
Moisture at 100° C.,	11.62
Calcium oxide,	0.57
Magnesium oxide,	0.60
Potassium oxide (4½ cents per pound),	1.31
Phosphoric acid (6 cents per pound),	2.09
Nitrogen (15 cents per pound),	3.59
Insoluble matter,	0.57
Valuation per ton,	$14 46

Gluten Meal (Chicago).

[Springfield, Mass.]

56.40 per cent. passed screen 144 meshes to square inch.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	10.45	209.00	–	–	
Dry matter,	89.55	1,791.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	0.85	17.00	–	–	
" cellulose,	0.67	13.40	5.55	34	1 : 2.11
" fat,	12.05	241.00	183.16	76	
" protein (nitrogenous matter),	38.17	763.40	648.89	85	
Non-nitrogenous extract matter,	48.26	965.20	907.29	94	
	100.00	2,000.00	1,744.89	–	

Gluten Meal.

[Springfield, Mass.]

54.10 per cent. passed screen 144 meshes to square inch.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	6.50	130.00	–	–	
Dry matter,	93.50	1,870.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	0.68	13.60	–	–	
" cellulose,	0.68	13.60	4.62	34	1 : 2.37
" fat,	10.03	204.60	155.49	76	
" protein (nitrogenous matter),	35.02	700.40	588.34	85	
Non-nitrogenous extract matter,	53.39	1,067.80	1,003.73	94	
	100.00	2,000.00	1,752.18	–	

Gluten Meal.

[I., sent on by S. N. Fletcher, South Acton, Mass.; II., sent on by J. L. Smith, Barre, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	7.30	10.70
Dry matter,	92.70	89.30
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	1.32	2.79
" cellulose,	1.14	6.40
" fat,	17.60	11.87
" protein (nitrogenous matter),	39.77	26.95
Non-nitrogenous extract matter,	40.17	51.99
	100.00	100.00
Passed screen 144 meshes to square inch,	84.80	65.64

Fertilizing Constituents of Gluten Meal.

	Per Cent.	
	I.	II.
Moisture at 100° C.,	7.300	10.70
Calcium oxide,	0.051	0.083
Magnesium oxide,	0.035	0.253
Ferric oxide,	0.070	–
Sodium oxide,	0.018	0.165
Potassium oxide (4¼ cents per pound),	0.045	0.099
Phosphoric acid (6 cents per pound),	0.429	0.718
Nitrogen (17 cents per pound),	5.900	3.850
Valuation per ton,	$20 61	$14 04

Buckwheat Middlings.

[Sent on by J. A. Cunningham, Bolton, Mass.]

	Per Cent.
Moisture at 100° C.,	11.51
Dry matter,	88.49
	100.00

Analysis of Dry Matter.

	Per Cent.
Crude ash,	5.44
" cellulose,	5.18
" fat,	7.53
" protein (nitrogenous matter),	25.49
Non-nitrogenous extract matter,	56.36
	100.00

71.40 per cent. passed screen 144 meshes to square inch.

Wheat Middlings.

[Sent on by F. H. Williams, Sunderland, Mass.]

	Per Cent.
Moisture at 100° C.,	12.43
Dry matter,	87.57
	100.00

Analysis of Dry Matter.

Crude ash,	4.21
" cellulose,	5.78
" fat,	3.38
" protein (nitrogenous matter),	15.13
Non-nitrogenous extract matter,	71.50
	100.00

94.16 per cent. passed screen 144 meshes to square inch.

Corn Fodder (Pride of the North).

[East Fields, collected Sept. 4, 1889.]

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	74.68	1,593.60	–	–	
Dry matter,	25.32	506.40	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	7.40	148.00	–	–	
" cellulose,	20.11	402.20	289.58	72	1 : 9.24
" fat,	1.65	33.00	24.75	75	
" protein (nitrogenous matter),	8.31	166.20	128.62	73	
Non-nitrogenous extract matter,	62.53	1,250.60	837.90	67	
	100.00	2,000.00	1,280.85	–	

Fertilizing Constituents of Corn Fodder.

	Per Cent.
Moisture at 100° C.,	74.680
Calcium oxide,	0.528
Magnesium oxide,	0.256
Ferric oxide,	0.078
Sodium oxide,	0.179
Potassium oxide,	0.921
Phosphoric acid,	0.495
Nitrogen,	0.337
Insoluble matter,	1.102
Valuation per ton,	$2 52

Corn Stover (Clark Corn).

[Station, Field A, 1889.]

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	5.77	115.40	–	–	
Dry matter,	94.23	1,884.60	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	7.64	152.80	–	–	
" cellulose,	33.70	674.00	485.28	72	1: 13.92
" fat,	1.77	35.40	26.55	75	
" protein (nitrogenous matter),	6.04	120.80	88.18	73	
Non-nitrogenous extract matter,	50.85	1,017.00	681.39	67	
	100.00	2.000.00	1,281.40	–	

Corn Stover (Pride of the North).

[Experiment Station, 1890.]

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	21.76	435.20	–	–	
Dry matter,	78.24	1,564.80	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	3.97	79.40	–	–	
" cellulose,	34.96	699.20	503.42	72	1:8.61
" fat,	1.54	30.80	23.10	75	
" protein (nitrogenous matter),	9.76	195.20	142.50	73	
Non-nitrogenous extract matter,	49.77	995.40	666.92	67	
	100.00	2,000.00	1,335.94	–	

Ensilage Corn (Pride of the North).

[Sept. 8, 1890.]

	Per Cent.
Moisture at 100° C.,	9.42
Dry matter,	90.58
	100.00
Analysis of Dry Matter.	
Crude ash,	6.01
" cellulose,	23.03
" fat,	2.76
" protein (nitrogenous matter),	9.31
Non-nitrogenous extract matter,	58.89
	100.00

Ensilage of Soja Bean and Cow-pea.

[Station, 1889.]

	Per Cent.
Moisture at 100° C.,	69.78
Dry matter,	30.22
	100.00

Analysis of Dry Matter.

	Per Cent.
Crude ash,	14.96
" cellulose,	31.53
" fat,	4.44
" protein (nitrogenous matter),	12.47
Non-nitrogenous extract matter,	36.60
	100.00

Fertilizing Constituents of Soja Bean and Cow-pea Ensilage.

	Per Cent.
Moisture at 100° C.,	9.780
Calcium oxide,	0.263
Magnesium oxide,	0.786
Ferric oxide,	0.369
Sodium oxide,	1.213
Potassium oxide (4½ cents per pound),	1.378
Phosphoric acid (6 cents per pound),	0.812
Nitrogen (17 cents per pound),	1.800
Insoluble matter,	4.777
Valuation per ton,	$8 46

Ensilage of Red-cob Corn.

[Station, 1889.]

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	74.48	1,489.60	–	–	
Dry matter,	25.52	510.40	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	6.55	131.00	–	–	
" cellulose,	28.48	569.60	410.11	72	1 : 13.68
" fat,	4.81	96.20	72.15	75	
" protein (nitrogenous matter),	6.55	131.00	95.63	73	
Non-nitrogenous extract matter,	53.61	1,072.20	718.37	67	
	100.00	2,000.00	1,296.26	–	

Ensilage of Pride of North Corn.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	71.41	1,428.20	–	–	
Dry matter,	28.59	571.80	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	6.41	128.20	–	–	
" cellulose,	24.19	483.80	348.34	72	1 : 10.17.
" fat,	5.53	110.60	82.95	75	
" protein (nitrogenous matter),	8.72	174.40	127.31	73	
Non-nitrogenous extract matter,	55.15	1,103.00	739.01	67	
	100.00	2,000.00	1,297.61	–	

Imported Seed of Scotch Tares.

	Per Cent.
Moisture at 100° C.,	14.26
Dry matter,	85.74
	100.00

Analysis of Dry Matter.

Crude ash,	4.15
" cellulose,	3.87
" fat,	7.38
" protein (nitrogenous matter),	32.08
Non-nitrogenous extract matter,	52.52
	100.00

Fertilizing Constituents of the Above.

Moisture at 100° C.,	14.26
Calcium oxide,	0.20
Magnesium oxide,	0.14
Ferric oxide,	0.02
Sodium oxide,	0.40
Potassium oxide,	1.29
Phosphoric acid,	1.02
Nitrogen,	4.24
Insoluble matter,	0.04
Valuation per ton,	$16 74

Vetch and Oats.

[Station, collected July 23, 1890.]

	Per Cent.
Moisture at 100° C.,	79.26
Dry matter,	20.74
	100.00

Analysis of Dry Matter.

Crude ash,	7.25
" cellulose,	31.73
" fat,	3.37
" protein (nitrogenous matter),	7.70
Non-nitrogenous extract matter,	49.95
	100.00

Fertilizing Constituents of Vetch and Oats.

Moisture at 100° C.,	5.78
Calcium oxide,	0.91
Magnesium oxide,	0.29
Ferric oxide,	0.02
Sodium oxide,	0.64
Potassium oxide,	2.24
Phosphoric acid,	0.63
Nitrogen,	1.16
Insoluble matter,	0.83
Valuation per ton,	$6 72

Royal English Horse and Cattle Condiment.

[I., from S. N. Thompson, Southborough, Mass.; II., from C. H. Heywood, Holyoke, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	10.30	10.82
Dry matter,	89.70	89.18
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	6.53	8.57
" cellulose,	3.59	4.52
" fat,	6.23	5.43
" protein (nitrogenous matter),	14.21	13.73
Non-nitrogenous extract matter,	69.44	67.75
	100.00	100.00

Harvey's Universal Vegetable Food.

[Sent on by E. F. Richardson, Millis, Mass.]

	Per Cent.
Moisture at 100° C.,	11.18
Dry matter,	88.82
	100.00

Analysis of Dry Matter.

Crude ash,	4.59
" cellulose,	7.06
" fat,	3.03
" protein (nitrogenous matter),	15.34
Non-nitrogenous extract matter,	69.98
	100.00
Passed screen 144 meshes to square inch,	72.98

Methods of Analysis of Cattle Foods.

1. Moisture. — Dry 2 grams in an air-bath at 100–110° C. to a constant weight.

2. Ash. — Char 2 to 5 grams in a muffle furnace at a low red heat, cool and weigh. Digest for a short time with dilute hydrochloric acid; collect the residue insoluble in acid in a Gooch crucible, wash, dry and weigh. Substract this from the total weight for pure ash.

3. Ether Extract. — Dry 2 grams at 100° C. for two hours. Exhaust with anhydrous, alcohol-free ether, until the extraction is complete. Dry the extract in the air-bath at 100° C. to a constant weight.

4. Crude Protein. — Determine nitrogen by the Kjeldahl or soda-lime method, and multiply the result by 6.25 for crude protein.

5. Albuminoid Nitrogen. — Determine by Stutzer's method, as given in the "Proceedings of the Association of Official Agricultural Chemists," 1889 (pages 226 and 227), except that the protein-copper is dried before being introduced into the flask.

6. Crude Fibre, or Cellulose. — The Weende method, as described in the "Proceedings of the Association of Official Agricultural Chemists," 1888 (page 70). In this method 2 grams of the material, having been nearly or completely freed from fat, are boiled for thirty minutes with 200 cubic

centimetres of $1\frac{1}{4}$ per cent. sulphuric acid, brought upon a linen filter and thoroughly washed with boiling water. It is then washed into the boiling-flask with a $1\frac{1}{4}$ per cent. solution of sodium hydrate, brought quickly to 100° C., and boiled for thirty minutes, when it is filtered through a Gooch crucible, or balanced filter-papers, washed with boiling water, alcohol and ether, dried at 100° C. for an hour, and weighed. The organic matter is then burned off, and the weight of the ash deducted for crude cellulose.

ON FIELD EXPERIMENTS.

V. Some suggestions regarding the question, How can we improve in an economical way the productiveness of our farm lands?

VI. Experiments to ascertain the effect of different combinations of nitrogen, nitrate of soda, sulphate of ammonia and organic-nitrogen-containing materials, blood, as well as the absence of nitrogen-containing manurial matter, under otherwise corresponding circumstances, on oats. (Field A.)

VII. Field experiments with prominent grasses and leguminous plants, to study their composition and general economical value in our section of the country. (Field B.)

VIII. Field experiments with reputed field and garden crops, to ascertain their adaptation to our soil and climate. (Fields C and D.)

IX. Field experiments to study the economy of using different commercial sources of phosphoric acid for manurial purposes in farm practice. (Potatoes. Field F.)

X. Experiments with grass land. (East Field Meadow.)

XI. Report on general farm work.

XII. Professor Humphrey's report. (On diseases of farm plants.)

V. Some Suggestions regarding the Question, How can we improve in an Economical Way the Productiveness of our Farm Lands?

An insufficient supply of suitable manurial matter, required for the successful and liberal production of the crops to be raised, is at present universally recognized as being the most fatal circumstance in any system of farming for profit. Adopting this conclusion as the correct verdict of past and present experience in agricultural industries, it becomes most desirable, in the interest of satisfactory pecuniary returns, that every available manurial resource of the farm should be turned to account to its full extent. To secure

this end we are advised to begin the work with a timely, thorough, mechanical preparation of the soil under cultivation; to select the crops to be raised, as far as practicable, with reference to their tendency of economizing existing natural resources of plant-food; to increase the latter to the full extent of suitable home-made manure on hand, and to supplement the latter liberally by buying commercial concentrated fodder articles and commercial fertilizer, as far as circumstances advise. To discuss briefly some of the means of developing and economizing manurial sources of the farm, is one of the objects of this communication. On the present occasion only two of those means will be discussed, which, although more or less at the disposition of every farmer engaged in mixed farm management, quite frequently do not receive that degree of consideration which they deserve, namely: —

1. A judicious selection and a liberal production of fodder crops.
2. An economical system of feeding farm live stock.

1. Production and Selection of Fodder Crops.

A careful inquiry into the history of agriculture, down to the middle of the present century, has shown that the original productiveness of farm lands in all civilized countries, even in the most favored localities, has suffered in the course of time a gradual decline. This general decline in the fertility of the soil under cultivation has been ascribed, with much propriety in the majority of instances, mainly to two causes: namely, a gradual but serious reduction in the area occupied by forage crops, natural pastures and meadows; and a marked decline in the annual yield of fodder upon large tracts of land but ill suited for a permanent cultivation of grasses, — the main reliance of fodder production at the time. A serious falling off in the annual yield of pastures and meadows was followed usually by a reduction in farm live stock, which, in turn, caused a falling off in the principal home resource of manurial matter. This chapter in the history of farm management has repeated itself in most countries. The unsatisfactory results of that system of

farming finds still an abundant illustration in the present exhausted condition of a comparatively large area of farm lands in New England.

Scientific investigations, carried on during the past fifty years for the particular benefit of agriculture, have not only been instrumental in recognizing the principal causes of an almost universal periodical decline of the original fertility of farm lands, but have also materially assisted, by field experiments and otherwise, in introducing efficient remedies to arrest the noted decline in the annual yield of our most prominent farm crops. As a scanty supply of manurial matter, due to a serious falling off of one of the principal fodder crops, was found to be one of the chief causes of less remunerative crops, and thus indirectly has proved to be the main cause of an increase in the cost of the products of the animal industry of the farm, — milk and meat, — it is but natural that the remedies devised should include, as one of the foremost recommendations, a more liberal production of nutritious fodder crops. The soundness of this advice is to-day fully demonstrated in the most successful agricultural regions of the world. An intensive system of cultivation has replaced in those localities the extensive one of preceding periods; although the area under cultivation for the production of general farm crops has been reduced, the total value of products of the farm have increased materially, in consequence of a more liberal cultivation of reputed fodder crops. The change has been gradual, and the results are highly satisfactory.

Viewing our own present condition, we notice that well-paying grass land, good natural meadow, with rich and extensive pastures, are rather an exception than the rule. The benefits derived from indifferently yielding natural pastures are more apparent than real; the low cost of the production of the fodder is frequently, in a large degree, set off by a mere chance distribution of the manure produced. A continued cultivation of one and the same crop upon the same land, without a liberal, rational system of manuring, has caused in many instances a one-sided exhaustion of the land under cultivation. This circumstance has frequently been brought about, in a marked degree, by a close

rotation of mixed grasses (meadow growth) and of our next main reliance for fodder, — the corn (maize). Both crops require potash and phosphoric acid, in similar proportion (4, potassium oxide, to 1, phosphoric acid), and both require an exceptional amount of the former. There is good reason to assume that the low state of productiveness of many of our farms, so often complained of, is largely due to the fact that crops have been raised in succession for years, which, like those mentioned, have consumed one or the other essential article of plant food in an exceptionally large proportion, and thereby have gradually unfitted the soil for their remunerative production; while a liberal supply of other important articles of plant food is left inactive behind. As the amount of available plant food contained in the soil represents largely the working capital of the farmer, it cannot be otherwise but that the practice of allowing a part of it to lie idle must reduce the interest on the investment.

Our personal observation upon the lands assigned for the use of the station has furnished abundant illustration of the above-described condition of farm lands. In one instance it was noticed that a piece of old, worn-out grass land, after being turned under and properly prepared, as far as the mechanical condition of the soil was concerned, produced, without any previous application of manure, an exceptionally large crop of horse-beans and lupine, — two reputed fodder crops. A similar observation was made during the past season, when lands, which for years had been used for the production of English hay and corn, were used for the cultivation of southern cow-pea, serradella, and a mixed crop of oats and vetch, to serve as green fodder for milch cows. The field engaged for the production of these crops was not manured, because it was to be prepared for a special field experiment during the present season. An area of this land, which, under favorable circumstances, would not produce more than six tons of green grass at the time of blooming, yielded nine to ten tons of green vetch and oats, ten tons of green southern cow-pea, and from twelve to thirteen tons of green serradella. The exceptional exhaustion of our lands in potash has been shown by detailed descrip-

tion of experiments with fodder corn in previous annual reports.

The results obtained during past years tend to confirm the opinion held by successful agriculturists, that dry grass lands which are in an exceptional degree inclined to a spontaneous overgrowing by an inferior class of fodder plants and weeds, if at all fit for a more thorough system of cultivation, ought to be turned by the plough and subsequently planted with some hoed crop, to kill off the foul growth and to improve the physical and chemical condition of the soil. These lands prove, in many instances, ultimately a far better investment when used for the raising of other farm crops than grasses. The less the variety of crops raised in succession upon the same lands, the more one-sided is usually the exhausted soil, and the sooner, as a rule, will be noticed a decrease in the annual yield. The introduction of a greater variety of fodder plants enables us to meet better the differences in local conditions of climate and of soil, as well as the special wants of different branches of farm industry. In choosing plants for that purpose, it seems advisable to select crops which would advantageously supplement our leading fodder crop (aside from the products of pastures and meadows), — the fodder corn and corn stover.

Taking this view of the question, the great and valuable family of leguminous plants, as clovers, vetches, lucerne, serradella, peas, beans, lupines, etc , is, in a particular degree, well qualified for that purpose. They deserve also a decided recommendation in the interest of a wider range, for the introduction of economical systems of rotation, under various conditions of soil and different requirements of markets. Most of these fodder plants have an extensive root system, and for this reason largely draw their plant food from the lower portion of the soil. The amount of stubble and roots they leave behind after the crop has been harvested is exceptionally large, and decidedly improves both the physical and chemical condition of the soil. The lands are consequently better fitted for the production of shallow-growing crops, as grains, etc. Large productions of fodder crops assist in the economical raising of general farm crops; although the area devoted to cultivation is

reduced, the total yield of the land is usually more satisfactory.

The subsequent tabular statement contains a list of fodder crops raised on the lands of the station. Those marked with * have been tried successfully on a large scale for fodder; the remainder seem to be well adapted to our climate. All are reported in their *dry* state, to compare their relative nutritive character, as well as the value of their fertilizing constituents. For further details, see seventh annual report, for 1889.

Composition of Fodder Crops raised upon the Station Grounds.

NAME OF CROP. (SUITABLE FOR FEEDING.)	Nutritive Ratio.	Fodder Constituents (in Pounds) in 1,000 Pounds of Dry Matter.					Fertilizing Constituents (in Pounds) in 1,000 Pounds of Dry Matter.			Manurial Value per Ton of Dry Matter.
		Crude Ash.	Crude Cellulose.	Crude Fat.	Crude Protein (Nitrogenous Matter).	Non-nitrogenous Extract Matter.	Nitrogen.	Phosphoric Acid.	Potassium Oxide.	
Medium clover (*Trifolium pratense*),		89.0	299.7	26.2	146.3	438.8	23.40	4.88	24.65	$10 64
Alsike clover (*Trifolium hybridum*),		116.7	261.8	26.6	162.2	432.7	25.88	7.81	24.72	11 86
*Cow-pea (*Dolichos*),	1 : 2.5	69.2	235.9	24.8	145.9	524.2	23.40	5.79	14.44	9 86
*Serradella (*Ornithopus sativus*),	to	116.9	324.9	23.7	149.6	384.9	23.94	8.04	24.12	11 15
*Vetch (*Vicia sativa*),	1 : 5.5	82.4	303.7	25.0	150.9	438.0	24.14	5.47	12.75	9 95
*Soja bean (*Soja hispida*),		75.1	212.6	59.9	154.0	497.5	24.78	4.66	16.53	10 39
Lucerne (*Medicago sativa*),		81.1	297.2	16.5	142.2	463.0	22.75	5.61	15.59	9 73
*Herds grass (*Phleum pratense*),		53.3	328.7	20.1	85.2	512.7	13.95	4.97	16.54	6 75
*Corn stover,		50.3	320.2	16.5	79.2	533.8	12.67	4.22	18.39	6 38
*Fodder corn,		48.8	314.0	15.3	72.1	549.8	11.54	7.38	10.99	5 75
*Oats (entire plant),	1 : 5.5	60.8	343.2	26.9	108.9	460.2	17.42	7.81	22.90	8 81
Barley (entire plant),	to	49.5	291.2	27.6	102.6	529.1	16.42	6.44	19.53	8 02
Millet,	1 : 9.5	54.9	335.4	17.4	75.9	516.4	12.14	5.03	10.89	5 66
Hungarian grass (*Setaria italica*),		71.5	246.6	10.1	93.8	578.0	15.01	6.24	13.50	7 00
Japanese buckwheat,		123.6	360.2	22.2	108.0	386.0	17.28	9.04	35.21	9 95
*Sugar beets,		46.4	60.0	6.5	108.4	778.7	17.34	5.41	18.57	8 12
*Ruta-bagas,	1 : 9.5	97.5	118.3	15.3	110.1	658.8	17.62	10.76	41.05	10 77
*Mangel-wurzels,	to	90.6	79.4	8.8	103.7	717.5	16.59	7.32	30.13	9 08
*Carrots,	1 : 13.	81.4	95.3	25.0	88.4	709.9	14.14	10.02	54.11	10 61

2. *Economical Feeding of Farm Live Stock.*

The adoption of an economical system of feeding farm live stock in the case of a mixed farm management is only second in importance, as far as financial success is concerned, to the remunerative production of the leading farm crops. The benefits derived from a successful management of the latter are not unfrequently largely offset by a mismanagement of the former. Comparatively recent investigations, regarding the principles which control success in feeding farm live stock for various purposes, have greatly improved our chances for profit. Although much needs still to be learned in regard to many details, it is quite generally conceded that some important facts, bearing on the economical side of the question, have been fairly established.

The introduction of the chemical analysis of fodder articles has made us more familiar with their general character. The influences which affect their composition are also better known. A fair knowledge in both directions is to-day considered indispensable for a due appreciation of the results obtained in feeding experiments. The latter, carried on under better-defined circumstances, have demonstrated the important fact that three distinctly different groups of substances are required for the support of the life of animals. These groups are: nitrogen-containing organic substances, commonly called nitrogenous organic matter; non-nitrogenous organic matter, like sugar, starch, fat, etc.; and certain saline or mineral substances. Neither one nor two of these groups by themselves can for any length of time sustain animal life; nor can any excess of one or the other, contained in the diet used, benefit the animal. The excess, as a rule, is ejected, and can only, if at all, benefit the manure. We know, also, that all our farm plants contain more or less of each of the three essential groups of food constituents. As no single plant or part of plant has proved to any extent to furnish the most nutritious and at the same time the most economical diet for any particular class of animals, it becomes advisable to supplement them with other suitable articles, to secure their full benefit. An economical system of stock feeding has, therefore, to strive

to select among the suitable fodder articles those which furnish the required quantity and proportion of the three essential food constituents in digestible form at the lowest cost. For more details regarding this point, I have to refer to previous annual reports.

Assuming a similar degree of adaptation of the various fodder articles offered for our choice, the question of cost deserves a serious consideration, when feeding for profit. The actual cost of a fodder article does not depend merely upon its market price, but is materially affected by the value of the manurial refuse it leaves behind, when it has served its purpose as food. The higher the percentage of nitrogen, phosphoric acid and potash a diet contains, the more valuable is the manure it furnishes, under otherwise corresponding circumstances. An excess, therefore, of any one or of all three in one diet, as compared with that of another, counts in favor of that particular diet, as far as the net cost of feed is concerned; for it is admissible, for mere practical economical purposes, to assume that, in raising one and the same kind of animals to a corresponding weight, or feeding them for the same purpose, a corresponding amount of nitrogen, phosphoric acid, potassium oxide, etc., will be retained, and, according to circumstances, either stored up in the growing animal, or pass into the milk, etc. The commercial value of the three above-mentioned essential articles of plant food, contained in the manure secured in connection with our feeding experiments with milch cows, has differed in case of different diets from less than one-third to more than one-half of the market cost of feed consumed. A few tabular statements may not be without interest on this occasion; for further illustration, I refer to our seventh annual report, — 1889.

1. Table showing the relative manurial value of stated fodder. Net cost signifies market cost, less manurial value.

2. Tables designed to show the approximate relative cost per pound of digestible nitrogenous matter of some prominent fodder articles. The calculation assumes in every case a value of nine-tenths cents per pound of digestible non-nitrogenous extract matter, and four and one-third cents for digestible crude fat. The difference between

the sum of the money values of fat and non-nitrogenous extract matter and cellulose present, and the market price of the particular fodder articles, is charged to the digestible nitrogenous matter. The corn meal has been adopted as the basis for the comparison, as far as value of non-nitrogenous matter is concerned. In presenting this table, it is by no means assumed that the nitrogenous matter, as stated below, is pound for pound of equal nutritive value; it merely aims to show what class of articles suggest themselves for trials, when an increase of nitrogenous matter is the main object for consideration in making up a class suitable for the occasion.

1. Valuation of Fodder Articles (per Ton).

	Market Cost.	Manurial Value.	Net Cost.
Corn meal, ...	$20 00	$7 50	$12 50
Wheat bran, ...	17 00	14 50	2 50
Wheat middlings, ...	20 00	10 75	9 25
Gluten meal, ...	24 00	17 00	7 00
Cotton-seed meal, ...	26 00	19 75	6 25
Linseed meal (old-process), . .	27 00	21 75	5 25
Linseed meal (new-process), . .	25 00	24 00	1 00
English hay (mixed), . . .	12 00	5 50	6 50
Corn fodder, ...	5 00	4 32	0 68
Corn stover, ...	5 00	4 80	0 20
Sugar beets, ...	5 00	1 15	3 85
Mangel-wurzels, ...	3 00	1 10	1 90
Skim-milk, ...	4 10	2 25	1 85

2. *Cost of Digestible Nitrogenous Matter of Fodder Articles (per Pound).*

[The constituents are given in pounds per 1,000 pounds of the substance which contains them.]

	Market Cost per Ton.	Moisture at 100° C.	Dry Matter.	Total Nitrogenous Matter.	Rate of Digestibility.	Digestible Nitrogenous Matter (Pounds).	Indigestible Nitrogenous Matter (Pounds).	Cost of Digestible Nitrogenous Matter per Pound, allowing for Digestible Fat Four and One-third Cents, for Cellulose and Non-nitrogenous Extract Matter Nine-tenths Cents, per Pound.	Total Nitrogen in Article.	Digestible Nitrogen.	Indigestible Nitrogen.
								Cents.			
Corn meal,	$20 00	128.6	871.4	98 47	85	83.70	14.77	3.30	15.66	13.31	2.35
Wheat bran,	17 00	109.7	890.3	158.36	88	139.36	19.00	2.21	25.33	22.29	3.04
Wheat middlings,	20 00	95.5	904.5	164.71	88	144.94	19.77	3.08	26.35	23.19	3.16
Gluten meal,	24 00	96.1	903.9	289.88	85	246.40	43.48	2.20	46.38	39.42	6.96
Cotton-seed meal,	26 00	80.8	919.2	388.09	74	287.20	100.89	2.41	62.09	45.95	16.14
Linseed meal (old-process),	27 00	74.8	925.2	343.70	87	299.02	44.68	2.50	54.99	47.84	7.15
Linseed meal (new-process),	25 00	60.1	939.9	383.08	87	333.28	49.80	2.40	61.29	53.32	7.97
Timothy hay,	12 00	85.7	914.3	75.97	57	43.30	32.67	3.10	12.15	6.93	5.22
English hay (mixed),	12 00	97.2	902.8	86.13	57	49.09	37.04	3.09	13.78	7.85	5.93
Corn fodder,	5 00	200.0	800.0	57.68	73	42.10	15.58	– *	9.23	6.74	2.49
Corn stover,	5 00	162.7	837.3	68.74	73	50.18	18.56	– *	11.00	8.03	2.97
Sugar beets,	5 00	835.2	164.8	19.17	100	19.17	0.00	6.47	3.07	3.07	0.00
Mangel-wurzels,	3 00	877.5	122.5	12.70	100	12.70	0.00	4.52	2.03	2.03	0.00
Skim-milk,	4 10	904.2	95.8	33.27	100	33.27	0.00	4.39	5.32	5.32	0.00

Approximate values.

* The digestible fat, cellulose and non-nitrogenous extract matter at stated prices more than cover the market cost.

Corn Ensilage (Six Samples).

[Sent on by J. H. Esterbrook for the Dudley Grange.]

Statements of Parties.

a. Variety of corn: —

1. Cross between Stowell's evergreen and eight-rowed variety.
2. Common field.
3. Eureka ensilage.
4. Southern white.
5. Stowell's evergreen.
6. Southern white.

b. Fertilization per acre: —

1. Three cords stable manure broadcast, with five hundred pounds ground bone in hill.
2. About thirty loads or ten cords stable manure broadcast, and two hundred pounds phosphate in hill.
3. Forty loads stable manure broadcast.
4. After a crop of rye for fodder, with five cords stable manure, four hundred pounds E. F. Coe's phosphate in drill.
5. Six cords horse manure, with three hundred pounds Bradley's fish in hill.
6. Two and one-half cords stable manure broadcast, on grass sod in the fall, and ploughed in with four hundred pounds of phosphate in drill when planting.

c. Mode of planting: —

1. Rows three feet apart; hills twenty-six inches apart; four kernels to hill.
2. Rows three and a half feet apart; hills twenty inches apart.
3. Rows three feet apart; hills twelve inches apart.
4. Rows three feet apart; kernels about three inches apart in drills.
5. Rows thirty-two inches apart; kernels about six inches apart in drills.
6. Rows three feet apart; kernels about one foot apart in drills.

d. Period of harvesting: —

1. Somewhat past the milk.
2. Over ripe; rather dry (September 23).
3. In the milk.
4. Ears commencing to form in the more exposed parts of the field.
5. Ears ripe enough for seed.
6. Past the milk (September 25).

e. Yield per acre (approximately): —

1. Eighteen to twenty tons.

2. About eight tons of ensilage and eighty bushels of ears. Estimated, thirty-five to forty tons; ten to fifteen feet high.
4. Twelve tons.
5. Twenty to twenty-two tons.
6. Twelve tons.

f. Mode of ensilaging: —

1. Cut in short pieces; silo filled in two days.
2. Cut in pieces one inch long.
3. Cut in short pieces by a Bailey cutter.
4. Cut in pieces one inch long by a Bailey cutter; covered with twelve inches of old hay or straw; then with inch boards and ten inches thickness of stones.
5. Cut in pieces three to four inches long by a Bailey cutter; silo filled in two days, covered and weighted.
6. Same as 4.

g. Fodder analysis: —

Sample.	Acidity calculated to Acetic Acid.	Moisture at 100° C.	Dry Matter.	Analysis of Dry Matter, 100 Parts.				
				Crude Ash.	Crude Cellulose.	Crude Fat.	Crude Protein (Nitrogenous Matter).	Non-nitrogenous Extract Matter.
	Per Cent.	Per Cent.	Per Cent.					
No. 1, .	3.68	76.38	23.62	6.18	20.05	5.57	8.49	59.71
No. 2, .	2.12	70.01	29.99	6.74	34.97	2.74	5.98	49.57
No. 3, .	1.98	82.87	17.13	7.22	38.92	1.82	6.04	46.00
No. 4, .	2.69	75.36	24.64	6.25	30.26	2.57	6.52	54.40
No. 5, .	1.27	78.84	21.16	6.94	24.40	3.78	7.53	57.35
No. 6, .	1.13	71.65	28.35	4.37	24.64	2.68	6.82	61.49

Observations made at the Laboratory.

No. 1. Best-looking sample, bright and fresh. Good per cent. of ears. Agreeable acid odor.

No. 2. Odor and appearance not as good as No. 1. Smaller per cent. of ears.

No. 3. Small per cent. of ears. Bright looking. Odor slightly sour.

No. 4. Fair per cent. of ears. Odor agreeable, but slightly sour. Not so bright looking as No. 1.

No. 5. Larger per cent. of ears. Odor agreeable. Color, fair. Small weeds and grass mixed in.

No. 6. Fair per cent. of ears. Color not as bright as No. 1. Smell, fair.

VI. Field Experiments to ascertain the Effect of Different Combinations of Nitrogen, Nitrate of Soda, Sulphate of Ammonia and Organic-nitrogen-containing Compounds, Blood, under Otherwise Corresponding Circumstances, on Oats. 1890. (Field A.)

The area occupied by this experiment is the same which has served during four preceding years in succession — 1884 to 1888 — for the purpose of ascertaining the extent of the inherent natural resources of potash. The results obtained in that connection, which are described in our third, fourth, fifth and sixth annual reports, left no doubt about the fact that our farm land had been in an exceptional degree impoverished in potash, in consequence of a too close rotation of grass and corn.

The field record of each of the ten plats, one-tenth of an acre in size, extended over a period of more than six years, as far as modes of cultivation and of manuring are concerned. Some plats had received during that period a supply of nitrogen for manurial purposes in but one and the same specified form, while others had received none in any form. This condition of the various plats was turned to proper account in our new plans.

1889 — Several plats which for five preceding years did not receive any nitrogen compound for manurial purposes, were retained in that state to study the effect of an entire exclusion of nitrogen-containing manurial substances on the crop under cultivation; while the remaining ones received, as before, a definite amount of nitrogen in the same form in which they had received it in preceding years; namely, either as sodium nitrate or as ammonium sulphate, or as organic nitrogenous matter in form of dried blood. A corresponding amount of available nitrogen was applied in all these cases.

Aside from the difference regarding the nitrogen supply, all plats were treated alike. They each received, without an exception, a corresponding amount of available phos-

phoric acid and of potassium oxide. The phosphoric acid was supplied in form of dissolved bone-black, and the potassium oxide either in form of muriate of potash or of potash-magnesia sulphate. From 120 to 130 pounds of potassium oxide, from 80 to 85 pounds of available phosphoric acid, and from 40 to 50 pounds of available nitrogen, were supplied per acre.

One plat, marked 0, received its main supply of phosphoric acid, potassium oxide and nitrogen in form of barn-yard manure; the latter was carefully analyzed before being applied, to determine the amount required to secure, as far as practicable, the desired corresponding proportion of essential fertilizing constituents. The deficiency in potassium oxide and phosphoric acid was supplied by potash-magnesia sulphate and dissolved bone-black. The fertilizer for this plat consisted of 800 pounds of barn-yard manure, 32 pounds of potash-magnesia sulphate, and 18 pounds of dissolved bone-black.

Plats 4, 7 and 9 received no nitrogen-containing manurial substance; plats 1 and 2 received nitrogen in form of sodium nitrate; plats 5, 6 and 8 received nitrogen in form of ammonium sulphate; plats 3 and 10 received nitrogen in form of dried blood; plat 0 received nitrogen in form of barn-yard manure.

The entire field, eleven plats, was ploughed April 9. The fertilizer was applied broadcast to each plat, and subsequently slightly harrowed under, April 27. The final preparation of the soil for seeding, by ploughing and harrowing, took place May 9. The same variety of corn (Clark), a flint corn, was planted in drills in a similar manner as during preceding years, May 10. The crop on all plats was kept clean by means of the cultivator and hoe; it was cut September 3, when the kernels were fairly glazed over.

Yield of Corn Stover and Ears on Plats (1889), at Forty-eight Per Cent. Moisture.

	Weight of Whole Crop.	Weight of Stover.	Weight of Ears.	Form of Nitrogen applied.
	Pounds.	Pounds.	Pounds.	
Plat 0,	500.62	342.35	158.27	Barn-yard manure.
Plat 1,	648.48	475.95	172.53	Nitrate of soda.
Plat 2,	576 91	375.75	201.16	Nitrate of soda.
Plat 3,	618.31	425 85	192.46	Blood.
Plat 4,	381.18	283.90	97.28	No nitrogen.
Plat 5,	488.01	359 05	128.96	Ammonium sulphate.
Plat 6,	541.95	367.05	174.90	Ammonium sulphate.
Plat 7,	525.82	484.30	41.52	No nitrogen.
Plat 8,	359.12	237.98	121.14	Ammonium sulphate.
Plat 9,	475.63	417.50	58.13	No nitrogen.
Plat 10,	639.55	467.60	171.95	Dried blood.

Percentage of Well-developed and Undeveloped Ears on Plats (1889).

	Well-developed Ears.	Undeveloped Ears.
	Per Cent.	Per Cent.
Plat 0,	60 3	39.7
Plat 1,	48.5	51.5
Plat 2,	46 7	53.3
Plat 3,	28.3	71.7
Plat 4,	14 7	85.3
Plat 5,	18.7	81.3
Plat 6,	29.0	71.0
Plat 7,	41.6	58.4
Plat 8,	21.3	78.7
Plat 9,	24.4	75.6
Plat 10,	50.2	49.8

The following tabular statement shows the general condition of the soil and its crop-producing quality during the years 1888 and 1889 : —

Field A.

NUMBER OF PLAT.	FERTILIZERS APPLIED.		YIELD OF DRY FODDER CORN.	
	1888.	1889.	1888.	1889.
Plat 1,	50 lbs. muriate of potash (= 25 lbs. potassium oxide),	25 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	617	648
Plat 2,	50 lbs. nitrate of soda (= 7 to 8 lbs. nitrogen),	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	303	577
Plat 3,	100 lbs. dissolved bone-black (= 17 lbs. available phosphoric acid).	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	150	618
Plat 4,	Nothing,	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	114	381
Plat 5,	97 lbs. magnesium sulphate,	22 5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 48 5 lbs potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	564	488
Plat 6,	Nothing,	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	193	542
Plat 7,	50 lbs. muriate of potash (= 25 lbs. potassium oxide),	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	676	526
Plat 8,	50 lbs. ammonium sulphate (= 10 lbs. nitrogen),	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	146	359
Plat 9,	50 lbs. muriate of potash (= 25 lbs. potassium oxide),	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	553	476
Plat 10,	97 lbs. potash-magnesia sulphate (= 25 lbs. potassium oxide) and 60 lbs. dried blood (= 7 to 8 lbs. nitrogen).	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	737	640

The results of our first season of observation, 1889, regarding the influence of nitrogen-containing manurial substances on the character and on the quantity of the fodder corn raised under otherwise corresponding circumstances, although not without some interest, were not decisive enough to advise a detailed explanation of causes. The larger part of the summer season of 1889 with us was cold and wet, and for this reason of an exceptionally unfavorable character for the raising of fodder corn. How much this circumstance has affected our first results, is difficult to decide. Not less difficult is it to decide, at this stage of observation, how much the special conditions of various plats may yet control the results. The comparatively low yield of ears and the large percentage of undeveloped ears, on plats 4, 7, 9, which received no nitrogen-containing manurial matter, was, however, very marked.

1890. — During the past season, oats was chosen as the crop for our trial. The field was prepared by ploughing in the fall and in the spring, previous to the manuring. The same kind and the same quantity of manurial substances were applied broadcast to the different plats as in the preceding year shortly before seeding.

NUMBER OF PLAT.	
Plat 0, .	800 lbs. of barn-yard manure, 32 lbs. of potash-magnesia sulphate and 18 lbs. of dissolved bone-black.
Plat 1, .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid.)
Plat 2, .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 3, .	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 4, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 5, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 6, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 7, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 8, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 9, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 10, .	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).

The above weights of the different manurial substances were taken for the purpose of securing to each plat, as far as practicable, potash, phosphoric acid and nitrogen in corresponding proportions.

The manurial substances were slightly harrowed under before seeding. The oats were seeded April 29 and 30, in rows, two feet apart, to allow a one-horse cultivator to pass between the rows. Each plat had sixteen rows, and thirty-nine pounds of oats, Pringle's Progress, were in equal weights divided between eleven plats. A brush seed drill with no plate under the brush was used for that purpose.

The young plants appeared above ground on May 5. The plants on plats 6 and 8 appeared sickly, having a yellowish tint, May 23. The entire field became subsequently somewhat infested with plant lice, plats 6 and 8 suffering most, May 26. Cultivator and hoe were used at this stage, to renovate the ground, June 2 and 3. The entire crop, with the exception of that upon Plat 8, soon improved and recovered entirely. Plat 8 suffered for some days longer than the rest from the infection; it showed later on a lower and somewhat uneven stand of its oats.

The shade of the green of the growth upon different plats showed during the progress of the season in many instances a quite marked difference. Upon plats which had received their nitrogen in the form of sulphate of ammonia, as well as upon those which had received no nitrogen-containing manurial matter, a light-green tint of the foliage was noticed alike in the earlier stages of the growth of the oats. In the latter case this light-green color of the crop remained until the maturing began; in the former case, *i. e.*, where sulphate of ammonia had furnished the nitrogen supply, the color became deeper green as the season progressed.

The progress of growth varied at times in a marked degree, yet no exceptional differences in height were noticeable at the maturing of the crop.

The following tabular statement contains the measurements of the height of the plants at stated dates: —

	June 20 (Inches).	June 27 (Inches).	July 4 (Inches).	July 11 (Inches).	July 18 (Inches).	July 25 (Inches).
Plat 0,	15	20	25	31	36	33
Plat 1,	16	19	25	31	36	36
Plat 2,	15	20	28	33	40	40
Plat 3,	14	17	21	30	34	36
Plat 4,	13	16	22	27	30	33
Plat 5,	15	19	28	34	38	40
Plat 6,	12	15	22	30	37	40
Plat 7,	12	15	20	28	35	36
Plat 8,	7	11	16	23	32	36
Plat 9,	12	13	21	27	31	35
Plat 10,	14½	19	24	32	40	40

The entire crop was cut August 11; it was removed to the barn August 13. To secure as far as practicable a uniform state of dryness, the final weighing of the yield of each plat was deferred to August 21, when the following results were obtained: —

	Grain and Straw (Pounds).	Grain (Pounds).	Straw and Chaff (Pounds).
Plat 0,	315	120	195
Plat 1,	362	128	234
Plat 2,	365	129	236
Plat 3,	345	116	229
Plat 4,	260	90	170
Plat 5,	360	141	219
Plat 6,	385	124	261
Plat 7,	320	110	210
Plat 8,	220	59	161
Plat 9,	290	101	189
Plat 10,	395	140	255
	3,617	1,258	2,359

Considering Plat 8 a failure for known cause, the low yield of kernels on plats 4, 7 and 9, which received no nitrogen application, is, to say the least, very significant.

Comparative Weights and Moisture Tests of the Above-recorded Grains.

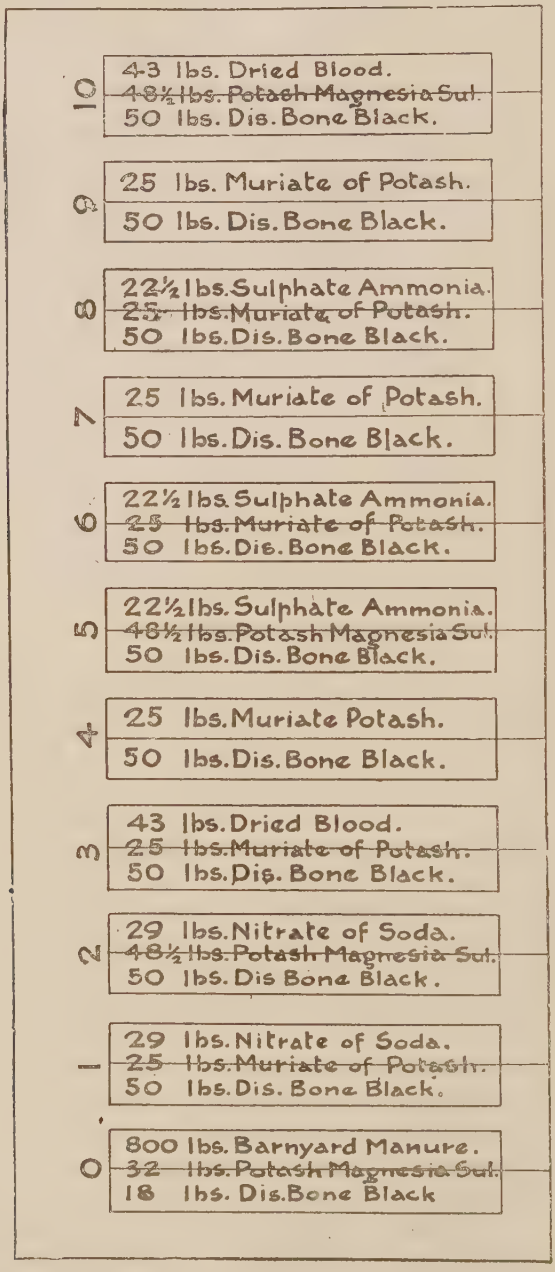
One hundred average kernels of each plat were taken for the test; three independent tests were made; the weights below recorded are the mean of the three tests made. The oats were kept in glass-stoppered bottles during the examination.

PLATS.	Average Weight of 100 Kernels (Grams).	Average Per Cent. of Water.	Percentage of Dry Matter.
0, ...	3.2151	16.96	83.04
1, ...	3.3577	17.58	82.42
2, ...	3.1236	17.43	82.57
3, ...	3.3260	20.88	79.12
4, ...	3.2991	20.99	79.01
5, ...	3.2015	18.79	81.21
6, ...	3.1201	22.60	77.40
7, ...	3.3956	22.22	77.78
8, ...	3.0727	17.74	82.26
9, ...	3.3408	23.94	76.06
10, ...	3.0740	18.34	81.66

The difference in moisture points evidently towards some varying degree in maturity. In the majority of cases where muriate of potash has furnished the potassa, the maturing of the crop was somewhat later than where sulphate of potassa was used.

PLAT.	Crop (Pounds).	Percentage of Grain.	Percentage of Straw and Chaff.	Dry Matter in Grain (Pounds).	Relative Percentage of Dry Matter in Grain.	Analysis of Dry Matter.		
						Potassium Oxide.	Phosphoric Acid.	Nitrogen.
						Per Cent.	Per Cent.	Per Cent.
0, .	315	38.10	61.90	99.66	86.97	0.82	1.13	2.62
1, .	362	35.36	64.64	105.50	92.13	0.76	1.21	2.75
2, .	365	35.34	64.66	106.52	93.02	0.75	1.02	2.72
3, .	345	33.62	66.38	91.78	80.15	0.84	1.21	2.49
4, .	260	34.61	63.39	71.11	62.09	0.79	1.08	2.53
5, .	360	39.20	60.80	114.51	100.00	0.85	0.96	2.68
6, .	385	32.21	67.79	95.98	83.82	0.90	1.15	2.64
7, .	320	34.40	65.60	85.56	74.72	0.80	1.06	2.36
8, .	220	26.82	73.18	48.53	42,30	0.84	1.09	2.64
9, .	290	34.83	65.17	76.82	67.08	0.80	0.97	2.59
10, .	395	35.44	64.56	114.33	99.84	0.84	1.08	2.59
Average,	329	34.54	65.46					

The absence of nitrogen in the manurial matter applied to plats 4, 7, 9, is accompanied by the lowest yield in dry matter in the grain; the yield of dried grain in case of plats 4, 7, 9, averages 67.9 per cent., and in case of the remaining plats, excluding Plat 8 for stated reasons, it averages 90.8 per cent. The plats containing potash-magnesia sulphate as the potash source, namely, plats 2, 5, 10, have yielded the largest amount of grain; each of these plats received its nitrogen supply in a different form, — ammonium sulphate, blood, and nitrate of soda. The field (A) has been seeded with winter rye during the late autumn, to continue the investigation in the same direction.


FIELD "A" 1890.
SCALE, 4 RODS TO 1 INCH.
OAT PLATS.
10
43 lbs. Dried Blood.
48½ lbs. Potash Magnesia Sul.
50 lbs. Dis. Bone Black.
9
25 lbs. Muriate of Potash.
50 lbs. Dis. Bone Black.
8
22½ lbs. Sulphate Ammonia.
25 lbs. Muriate of Potash.
50 lbs. Dis. Bone Black.
7
25 lbs. Muriate of Potash.
50 lbs. Dis. Bone Black.
6
22½ lbs. Sulphate Ammonia.
25 lbs. Muriate of Potash.
50 lbs. Dis. Bone Black.
5
22½ lbs. Sulphate Ammonia.
48½ lbs. Potash Magnesia Sul.
50 lbs. Dis. Bone Black.
4
25 lbs. Muriate Potash.
50 lbs. Dis. Bone Black.
3
43 lbs. Dried Blood.
25 lbs. Muriate of Potash.
50 lbs. Dis. Bone Black.
2
29 lbs. Nitrate of Soda.
48½ lbs. Potash Magnesia Sul.
50 lbs. Dis Bone Black.
1
29 lbs. Nitrate of Soda.
25 lbs. Muriate of Potash.
50 lbs. Dis. Bone Black.
0
800 lbs. Barnyard Manure.
32 lbs. Potash Magnesia Sul.
18 lbs. Dis. Bone Black

VII. Field Experiments with Prominent Fodder Crops, to study Their Composition and Their General Economical Value in our Section of the Country. — Grasses and Leguminous Plants (Field B).

The field here under discussion is located west of Field A, described within some preceding pages. It occupies an area of one and seven-tenths acres. The land is nearly level, and the soil consists of a sandy loam several feet deep.

In 1884 the entire field was subdivided into eleven plats of equal size, thirty-three by one hundred and seventy-five feet, with five feet of space between them. Every alternate plat has received from that date annually the same kind and the same amount of fertilizer, — six hundred pounds of ground bones and two hundred pounds of muriate of potash per acre. Since 1885 all crops on that field have been raised in rows; this system of cultivation became a necessity in the case of grasses, clovers, etc., to secure a clean crop for observation. The rows, in the case of corn and leguminous plants, were three feet and three inches apart; and, in the case of grasses, two feet. The space between the different plats has received, thus far, no manurial substance of any description, and is kept clean from vegetation by a proper use of the cultivator. Plats 11, 13, 15, 17, 19 and 21 were fertilized annually; plats 12, 14, 16, 18 and 20 have received no fertilizer until the season of 1889.

The details of the work carried on upon Field B are from year to year recorded in the annual report of the station. As the chemical analyses of the crops raised require considerable time, on account of other contemporary pressing engagements in the laboratory, they are usually published in bulletins, and the reports of the succeeding year.

The subsequent tabular statement of crops raised upon the different plats of Field B since 1886 may assist in a desirable understanding of its late history, and its condition at the beginning of the season of 1890.

PLATS.	1887.	1888.	1889.	1890.
Plat 11 (fertilized),	Corn,	Kentucky blue-grass (*Poa pratensis*),	Kentucky blue-grass,	Kentucky blue-grass, sown Sept. 24, 1889.
Plat 12 (unfertilized),	Corn,	Kentucky blue-grass,	Kentucky blue-grass,	Kentucky blue-grass, sown Sept. 24, 1889.
Plat 13 (fertilized),	Italian rye-grass (*Lolium Italicum*), English rye-grass (*Lolium perenne*),	Italian rye-grass, English rye-grass,	Red-cob ensilage corn,	Red top, sown Sept. 24, 1889.
Plat 14 (unfertilized),	Italian rye-grass, English rye-grass,	Italian rye-grass, English rye-grass,	Red-cob ensilage corn,	Red top, sown Sept. 24, 1889.
Plat 15 (fertilized),	Five varieties Southern cow-pea,	Soja bean (*Soja hispida*),	Bokhara clover (*Melilotus alba*), Sainfoin (*Onobrychis sativa*),	Bokhara clover, sown May 8, 1889. Sainfoin, sown May 8, 1889.
Plat 16 (unfertilized),	Five varieties Southern cow-pea,	Soja bean,	Bokhara clover, Sainfoin,	Rhode Island bent (*Agrostis alba*), sown Sept. 25, 1889.
Plat 17 (fertilized),	Meadow fescue (*Festuca pratensis*),	Meadow fescue,	Meadow fescue,	Meadow fescue, sown September, 1887.
Plat 18 (unfertilized),	Alsike clover (*Trifolium hybridum*), Medium red clover (*Trifolium pratense*),	Alsike clover, Medium red clover,	Red-cob ensilage corn,	Meadow fescue, sown September, 1889.
Plat 19 (fertilized),	Alsike clover, Medium red clover,	Alsike clover, Medium red clover,	Alsike clover, Medium red clover,	Herds grass, sown September, 1889.
Plat 20 (unfertilized),	Mammoth red clover (*Trifolium medium*), Alfalfa or lucerne (*Medicago sativa*),	Mammoth red clover, Alfalfa,	Red-cob ensilage corn,	Red top and herds grass, mixed, sown September, 1889.
Plat 21 (fertilized),	Mammoth red clover, Alfalfa,	Mammoth red clover, Alfalfa,	Corn (variety, Clark),	Meadow fescue and herds grass, mixed, sown September, 1889.

The fertilizer annually applied since 1889 to all the plats alike consisted in each case of eighty pounds of steamed ground bones and of twenty-seven pounds of muriate of potash, or six hundred pounds of bones and two hundred pounds of muriate of potash per acre.

1890. — A grass mixture was sown broadcast on plats 20 and 21. The remaining plats were sown in drills two feet apart, sixteen rows in each plat. The crops seeded in rows were cultivated two or three times, and cleaned with the hoe during the growing season to remove the weeds and to clear the crops from admixtures.

The majority of the plats appeared well at the beginning of the season. The seeds proved, however, subsequently, in several instances, a bad investment for our purposes, where distinct varieties and not mixtures of grass seeds were needed.

Plats 11, 12, Kentucky blue-grass, sown Sept. 24, 1889. The growth looked well at the opening of spring, 1890. The cultivator and hoe were applied in the beginning of the season, and again in June, to remove the weeds. The crop was cut for the first time September 19; it did not head out during the season. The hay weighed two hundred pounds on Plat 11, and two hundred and sixty pounds on Plat 12.

Plats 13, 14, red top (*Agrostis vulgaris*), sown Sept. 24, 1889. The seed proved not well adapted to our purpose. It contained a considerable amount of seeds of herds grass. The crop was cut on both plats July 10, and yielded seven hundred and ten pounds of hay in all. The sod was subsequently ploughed under, and cut up by means of a wheel harrow. The soil prepared later on was reseeded Sept. 24, 1890.

Plat 15, Bokhara clover (*Melilotus alba*) and esparsette or sainfoin (*Onobrychis sativa*). Both were sown May 8, 1889. The Bokhara clover yielded, September 9, two hundred and three pounds of hay; the sainfoin did not head out in the first year, — it reached about five inches in height. Both crops looked fairly well in the spring of 1890, yet showed here and there the effects of winter-killing. They were cut for hay; Bokhara clover yielded two cuts, sainfoin but one. Bokhara clover was cut June 24, yielding two

hundred and five pounds of hay, and again September 22, yielding seventy-five pounds. Sainfoin was cut June 24, and yielded one hundred and twenty-five pounds of hay; the aftergrowth would have furnished a rich pasture for cows.

Plat 16, Rhode Island bent (*Agrostis alba*), sown Sept. 25, 1889. The growth looked promising at the opening of the season, yet turned out later on to contain a considerable admixture of herds grass. The crop was cut July 9, and it yielded three hundred and twenty pounds of hay. The sod was turned under July 15, and cut up with a wheel harrow. The plat, after thorough preparation, was reseeded in September, 1890.

Plat 17, meadow fescue (*Festuca pratensis*), sown September, 1887. Started out vigorously with an unbroken sod; began blooming during the first week of June, and was nearly through blooming June 20. It was cut June 24, and measured from three to three and a half feet in height. Two crops were secured, June 24 and September 22. The first cut yielded seven hundred and thirty pounds of hay, and the second cut two hundred and fifty-five pounds.

Plat 18, meadow fescue, sown Sept. 22, 1889. The seed proved, to a serious degree, to be a mixture of grass seeds. The crop was cut July 9, and yielded three hundred and ninety pounds of hay. The sod was ploughed under July 15, cut up with a wheel harrow, and subsequently, after due preparation, reseeded Sept. 24, 1890.

Plat 19, herds grass (*Phleum pratense*), sown Sept. 25, 1889. Looked well in the spring; began to blossom June 30; was cut July 9. It yielded five hundred and fifty pounds of hay. The second crop was cut September 22, and yielded two hundred and five pounds of hay.

Plat 20, a mixture of herds grass, two and one-half pounds (= 2 quarts), and red top, two and one-half pounds (= 6 quarts), which were sown Sept. 24, 1889. The crop looked fair in the spring; was cut July 9; it yielded four hundred and thirty pounds of hay, first cut. The grass suffered somewhat from a brown fungus. The sod was for this reason ploughed under, and the soil prepared, in the

same manner as previously described in case of other plats, for a reseeding during the succeeding September.

Plat 21, a mixture of meadow fescue, two and one-half pounds (= 4 quarts), and herds grass, two and one-half pounds (= 2 quarts), was sown Sept. 25, 1889. The plat looked well in the spring; it proved in part a failure, on account of the mixed character of the seeds, and of the appearance of a brown fungus upon the plants. The first cut yielded three hundred and ninety pounds of hay. The sod was ploughed under soon after harvesting the hay, and the land reseeded after a careful preparation of the soil, Sept. 25, 1890.

All plats reseeded during the late autumn have been fertilized in a like manner, with the same mixture which has been used for several years upon Field B; namely, six hundred pounds of ground steamed bones and two hundred pounds of muriate of potash per acre. Extra precaution has been taken to secure seeds fit for our purpose, which in this connection consists in comparing single varieties of grasses and other reputed fodder crops, regarding their nutritive character and their comparative economical value, when raised under otherwise corresponding circumstances upon farms in Massachusetts.

Some of the results of the analyses of crops raised upon Field B, during 1889 and 1890, as far as they are not yet published, will be found upon a few subsequent pages.

Meadow Fescue.

[In full bloom, June 14, 1889. (Field B.)]

	Per Cent.
Moisture at 100° C.,	5.30
Dry matter,	94.70
	100.00

Analysis of Dry Matter.

Crude ash,	8.50
" cellulose,	39.65
" fat,	1.97
" protein (nitrogenous matter),	7.85
Non-nitrogenous extract matter,	42.03
	100.00

Fertilizing Constituents of Meadow Fescue.

	Per Cent.
Moisture at 100° C.,	5.300
Calcium oxide,	0.616
Magnesium oxide,	0.269
Ferric oxide,	0.019
Sodium oxide,	0.603
Potassium oxide,	2.461
Phosphoric acid,	0.625
Nitrogen,	1.190
Insoluble matter,	0.151
Ash,	8.500
Valuation per ton,	$6 89

Kentucky Blue-grass.

[Collected June 14, 1889; just past blooming. (Field B.)]

	Per Cent.	
	Fertilized.	Unfertilized.
Moisture at 100° C.,	6.78	3.90
Dry matter,	93.22	96.10
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	8.24	7.45
" cellulose,	36.84	32.21
" fat,	2.03	2.08
" protein (nitrogenous matter),	8.78	8.65
Non-nitrogenous extract matter,	44.11	49.61
	100.00	100.00

Fertilizing Constituents of Kentucky Blue-grass.

	Per Cent.	
	Fertilized.	Unfertilized.
Moisture at 100° C,	6.780	3.900
Calcium oxide,	0.366	0.429
Ferric oxide,	0.031	0.057
Sodium oxide,	0.067	0.181
Potassium oxide,	2.110	1.277
Phosphoric acid,	0.414	0.447
Nitrogen,	1.310	1.330
Insoluble matter,	3.203	2.522
Valuation per ton,	$6 74	$5 66

Alsike Clover.

[Collected June 14, 1889; in full bloom. (Field B.)]

	Per Cent.
Moisture at 100° C.,	9.96
Dry matter,	90.04
	100.00

Analysis of Dry Matter.

Crude ash,	13.06
" cellulose,	26.11
" fat,	2.19
" protein (nitrogenous matter),	16.65
Non-nitrogenous extract matter,	41.99
	100.00

Fertilizing Constituents of Alsike Clover.

	Per Cent.
Moisture at 100° C.,	9.960
Calcium oxide,	1.870
Ferric oxide,	0.104
Sodium oxide,	0.266
Potassium oxide,	3.320
Phosphoric acid,	0.495
Nitrogen,	2.399
Insoluble matter,	1.928
Valuation per ton,	$11 57

Medium Clover.

[Collected July 12, 1889; in full bloom. (Field B.)]

	Per Cent.
Moisture at 100° C.,	5.10
Dry matter,	94.90
	100.00

Analysis of Dry Matter.

Crude ash,	9.06
" cellulose,	30.76
" fat,	2.36
" protein (nitrogenous matter),	15.01
Non-nitrogenous extract matter,	42.81
	100.00

Fertilizing Constituents of Medium Clover.

	Per Cent.
Moisture at 100° C.,	5.100
Calcium oxide,	1.539
Ferric oxide,	0.137
Sodium oxide,	0.227
Potassium oxide,	2.370
Phosphoric acid,	0.457
Nitrogen,	2.279
Insoluble matter,	1.583
Valuation per ton,	$10 35

Sweet Clover (Melilotus alba).

[Collected Oct. 3, 1889. (Field C.)]

	Per Cent.
Moisture at 100° C.,	6.36
Dry matter,	93.64
	100.00

Analysis of Dry Matter.

Crude ash,	6.90
" cellulose,	28.08
" fat,	1.85
" protein (nitrogenous matter),	11.81
Non-nitrogenous extract matter,	51.36
	100.00

Fertilizing Constituents of Sweet Clover.

	Per Cent.
Moisture at 100° C.,	6.360
Calcium oxide,	1.938
Magnesium oxide,	0.373
Ferric oxide,	0.025
Sodium oxide,	0.077
Potassium oxide,	1.673
Phosphoric acid,	0.436
Nitrogen,	1.770
Insoluble matter,	0.013
Valuation per ton,	$7 96

Sainfoin (Onobrychis sativa).

[Past blooming; collected June 20, 1890.]

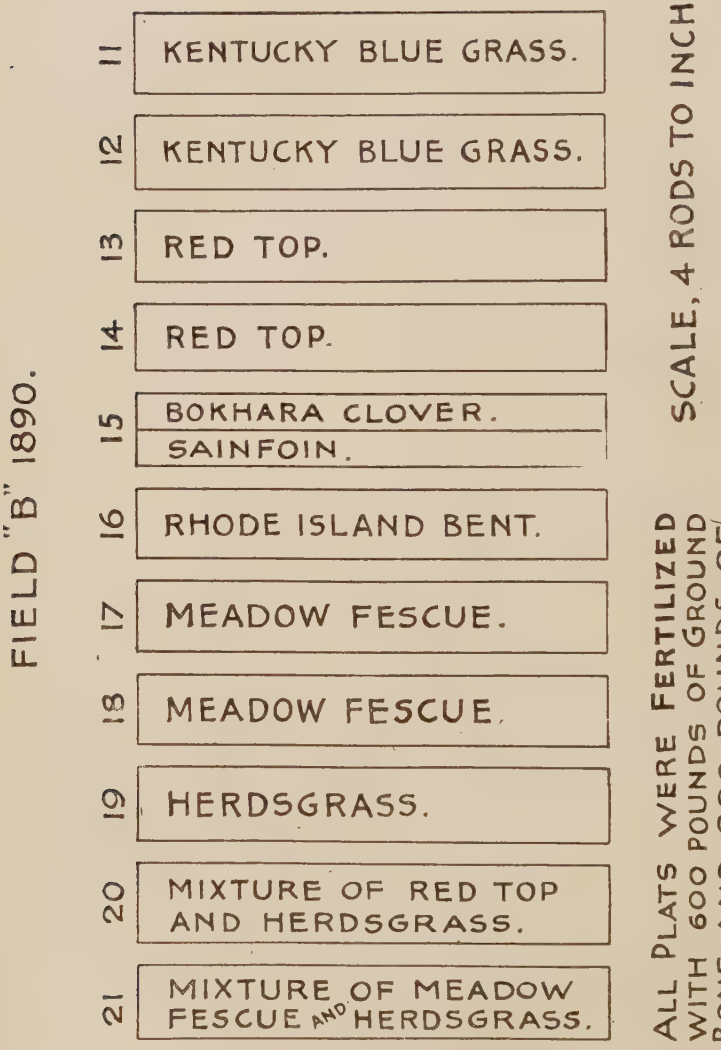
	Per Cent.
Moisture at 100° C.,	12.17
Dry matter,	87.83
	100.00

Analysis of Dry Matter.

	Per Cent.
Crude ash,	8.54
" cellulose,	26.95
" fat,	4.49
" protein (nitrogenous matter),	17.70
Non-nitrogenous extract matter,	42.27
	100.00

Fertilizing Constituents of Sainfoin.

	Per Cent.
Moisture at 100° C.,	12.17
Calcium oxide,	1.16
Magnesium oxide,	0.43
Ferric oxide,	0.04
Sodium oxide,	0.54
Potassium oxide,	2.02
Phosphoric acid,	0.76
Nitrogen,	2.63
Insoluble matter,	0.47
Valuation per ton,	$11 57


FIELD "B" 1890.
11
KENTUCKY BLUE GRASS.
12
KENTUCKY BLUE GRASS.
13
RED TOP.
14
RED TOP.
15
BOKHARA CLOVER.
SAINFOIN.
16
RHODE ISLAND BENT.
17
MEADOW FESCUE.
18
MEADOW FESCUE.
19
HERDSGRASS.
20
MIXTURE OF RED TOP AND HERDSGRASS.
21
MIXTURE OF MEADOW FESCUE AND HERDSGRASS.
SCALE, 4 RODS TO INCH.
ALL PLATS WERE FERTILIZED WITH 600 POUNDS OF GROUND BONE AND 200 POUNDS OF MURIATE OF POTASH PER ACRE.

VIII. Experiments with Field and Garden Crops. (Fields C and D.)

Field C.

This field comprises an area 328 feet long and 183 feet wide; it is subdivided into two parts, running from east to west; they are separated by a passage-way three feet wide.

The system of manuring and of cultivating is the same on both divisions. They are annually manured with a mixture consisting of fine-ground steamed bone, six hundred pounds, and muriate of potash, two hundred pounds, per acre. The field is usually ploughed in the fall and early in spring, with the exception of small areas occupied by perennial plants. The fertilizer is applied broadcast early in spring, and subsequently slightly harrowed in.

The crops are in the majority of cases planted in drills, to secure chances for clean cultivation. The land has served, for several years past, for the same purposes; namely, to ascertain the particular degree of adaptation of reputed farm crops to our climate and our soil. In some instances sufficient quantities of one or the other were raised to furnish fodder for summer and winter feeding experiments. In the majority of cases, however, the main object of the planting was to secure suitable material for analysis, to determine their relative economical value either for general farm purposes or for special industrial purposes. The variety of crops already tested in this connection is quite numerous; for details regarding previous years, we have to refer to our preceding annual reports. Some analyses of crops raised on fields C and D during the year 1889 are published, for the first time, within a few subsequent pages.

Lotus villosus.
Sulla (*Hedysarum coronaria*).
Teosinte.
Japanese buckwheat.
Small pea (*Lathyrus sativus*).
Carrot (*Daucus carota*).

1890. — The entire field, both divisions, was ploughed during the autumn of 1889, and again May 1, 1890. The

fertilizer, six hundred pounds of fine-ground bones and two hundred pounds of muriate of potash, per acre, was sown soon after the ploughing, slightly harrowed under, and the various seeds subsequently planted as stated below.

The entire south side of Field C was planted with barley, in rows two feet apart. The north side was occupied by a series of crops in the following order, beginning at the east end of the field : —

5 rows English rye grass, rows two feet apart.
3 rows early Southern white corn, rows three feet three inches apart.
2 rows early Southern cow-pea, rows three feet three inches apart.
4 rows horse bean, rows three feet three inches apart.
4 rows white soja bean, rows three feet three inches apart.
4 rows black soja bean, rows three feet three inches apart.
2 rows bush peas, rows three feet three inches apart.
4 rows Scotch tares, rows three feet three inches apart.
4 rows common vetch, rows three feet three inches apart.
4 rows white lupine, rows three feet three inches apart.
4 rows serradella, rows three feet three inches apart.
4 rows Bokhara clover, rows three feet three inches apart.
4 rows sainfoin, rows three feet three inches apart.
4 rows English rye grass, rows two feet apart.
1 row sulla.
1 row festuca No. 1 (Connecticut).
2 rows pyrethrum, rows two feet apart.
3 rows lotus villosus, rows three feet three inches apart.
15 rows Florimond Desprez's richest sugar beet, rows two feet apart.
15 rows Bulteau Desprez's richest sugar beet, rows two feet apart.
15 rows Dippe's Kleinwanzleben sugar beet, rows two feet apart.
15 rows Dippe's Vilmorin sugar beet, rows two feet apart.
16 rows Simon Le Grand's white improved sugar beet, rows two feet apart.

The entire field was kept clean from weeds by a timely use of a one-horse cultivator and the hoe.

Barley. — The area occupied by barley was 30,504 square feet. It required thirty-four pounds of seed, or forty-eight to fifty pounds per acre. The seed was planted with a brush seeding machine, without plate, May 3. The young plants began to come up May 6. They were cultivated June 3, and headed out June 25. The heads remained free from smut, but the leaves showed many brown spots, due to fungous growth.

The crop reached a height of twenty-five inches, and turned yellow July 25. It was cut July 31, and put in the

barn August 3. When threshed, September 15, it yielded 430 pounds of grain and 1,795 pounds of straw and chaff, which is equal to 610 pounds of grain and 2,531 pounds of straw and chaff, per acre.

The ground which was used for the production of the barley was ploughed August 2. After being fertilized with 225 pounds of fine-ground steamed bone (one-half of our customary annual dressing of bone), it was planted with turnips and ruta-bagas, in rows two feet apart. The crop was thinned out in the rows and twice cleaned with the cultivator. It was harvested November 5. The turnips came to a good average size, and the ruta-bagas only to a small medium size. Both were of excellent quality for family use, selling in our local market at fifty cents per bushel. The entire crop amounted to 7,715 pounds.

English Rye Grass (*Lolium perenne*). — This was sown May 30. The young plants appeared above ground June 5. They made a good growth, yet did not head out during the season. The grass was cut at the customary time for second cut of upland meadow grasses, and the sod left over winter, to notice the effect of that season on the crop. In one of our preceding experiments the plants were winter-killed. The main object of this trial was to secure additional facts regarding that point.

Early Southern White Corn. — The corn was planted May 23. The young plants were noticed above ground June 2. It made a very heavy rank growth, yet proved much too late for maturing in our locality.

Horse Bean (*Vicia faba*). — This was planted May 23, appeared above ground June 2; reached a height of twenty-five inches before it began to bloom, July 9. It suffered temporarily somewhat from drought; recovered, however, subsequently. The roots of the plants, when thirty-one inches high, July 18, showed a remarkably large number of tubercles. The plant keeps on blooming until a killing frost destroys it. This plant has served us well on former occasions for green manuring.

Soja Bean (*Soja hispida*). — Two varieties, white and black, were planted May 23; they came above ground June 2. The white variety began to bloom August 9, and

the black variety but one day later. The foliage of the white variety was darker green than that of the black, throughout the season. Both stood the drought well. The roots had apparently no tubercles. The white variety matured sooner than the black one. The soja bean promises to be a valuable addition to the leguminous fodder crops in New England. Two acres have been planted with soja beans during the past season, on the grounds of the station. The growth of one acre has served, in its semi-matured state, as green fodder during the autumn (see summer feeding experiment on previous pages of this report) for milch cows; and that of the other has been put in a silo as an admixture to corn ensilage (see statements on silos).

Scotch Tares (a coarse variety of vetch). — The seed was kindly furnished by Mr. James Cheesman of Southborough, Mass., who had imported some for his own experiments. It was planted May 23, was above ground June 3; had reached a height of twelve inches, July 18, before it began to spread. The plants began blooming July 23. The crop was cut for hay August 2. One acre has been planted on another part of our farm during the past season, to serve as winter fodder for cattle.

Common Vetch (*Vicia sativa*). — The seed was planted May 23; the young plants were above ground June 1. They began to bloom July 12, when twelve inches high. The plants formed subsequently a rank, thick growth. This variety of vetch has been raised for several years very successfully on our farm, either by itself or as an admixture of oats and barley, for green fodder, toward the close of July, when they begin to bloom. It is one of the earliest annual leguminous fodder crops at our disposal, and has rendered us for several years past excellent services as green fodder for milch cows. It can be used green or in its dried state, as circumstances advise. An admixture of oats and barley renders the crop very acceptable to dairy stock.

White Lupine (*Lupinus alba*). — This was planted May 23; appeared above ground June 1; began to blossom July 7, and reached a height of twenty-five inches. The crop became infested with insects, and proved no success during the past season. The best services we have thus far

received from the various varieties of lupines, white, yellow and blue, consists in their fitness for green manuring. The plant grows rapidly, is succulent, and comparatively rich in nitrogenous matter. The crop can be ploughed under with profit in the beginning of August. The disintegration of the plant has usually sufficiently advanced at the beginning of September to render the soil fit for thorough mechanical preparation, preparatory to the seeding down of grasses or of winter crops.

Serradella (*Ornithopus sativus*). — The successful cultivation of this valuable fodder crop depends, in our part of the country, apparently in exceptional degrees, on the character of the soil and the season. A deep, sandy loam, and a fair average temperature of the summer season, tend to secure success. Under favorable circumstances we have obtained from ten to twelve tons of green fodder, with an average percentage of dry matter of from nineteen to twenty per cent. Fed green from the beginning to the end of September, 1887 and 1889, at the rate of seventy to eighty pounds per day, with one-quarter of the ordinary English hay ration (five pounds), the result has been in an exceptional degree satisfactory. Serradella has surpassed in our case the effect of Southern cow-pea and vetch and oats, as a green fodder for dairy cows. It competes fairly with soja bean in that connection. Cold and wet summer seasons, and cold, springy lands, each in their own way interfere seriously with a timely vigorous growth, and thus with the production of a remunerative crop. Our trial with this crop during the late season has been a failure, on account of the springy character of the land selected for its cultivation.

Bokhara Clover (*Melilotus alba*) and *Sainfoin* (*Onobrychis sativa*, — *Esparsette*) are already described in previous pages (Field B). The bulky, heavy growth of the Bokhara clover, and its pleasant odor, resembling somewhat that of the sweet vernal grass (*Anthoxanthum odoratum*), render it desirable to institute experiments for the purpose of ascertaining its fitness for ensilage. Its stems are succulent at the time when the plant has reached its full height (four to four and one-half feet). Our locality is evidently too cold to render the cultivation of sainfoin advisable.

Sulla (*Hedysarum coronaria*) and *Lotus villosus* have for several years shown a healthy and vigorous growth on our grounds; they stand our average winter very well. Both deserve a serious trial for stocking pastures with a nutritious growth. They shade the ground more efficiently in such localities than any of our coarser clover varieties. Some subsequent statements of their composition illustrate their high feeding value.

Sugar Beets. — The seeds were sent on by the United States Department of Agriculture, for trial, accompanied by the directions to return in due time average specimens of roots of the five varieties for examination at the laboratory of the department in Washington.

They were planted in rows two feet apart, in a well-prepared soil, May 5, each variety properly marked. The young plants came up May 17; they suffered subsequently somewhat from leaf-miners, but soon recovered without any apparent serious consequences. The crop was cleaned twice with the cultivator, and the plants thinned out to six inches apart July 8. They suffered during the latter part of the summer here and there from brown spots on the leaves. The pulling of the roots began October 2, with the following.

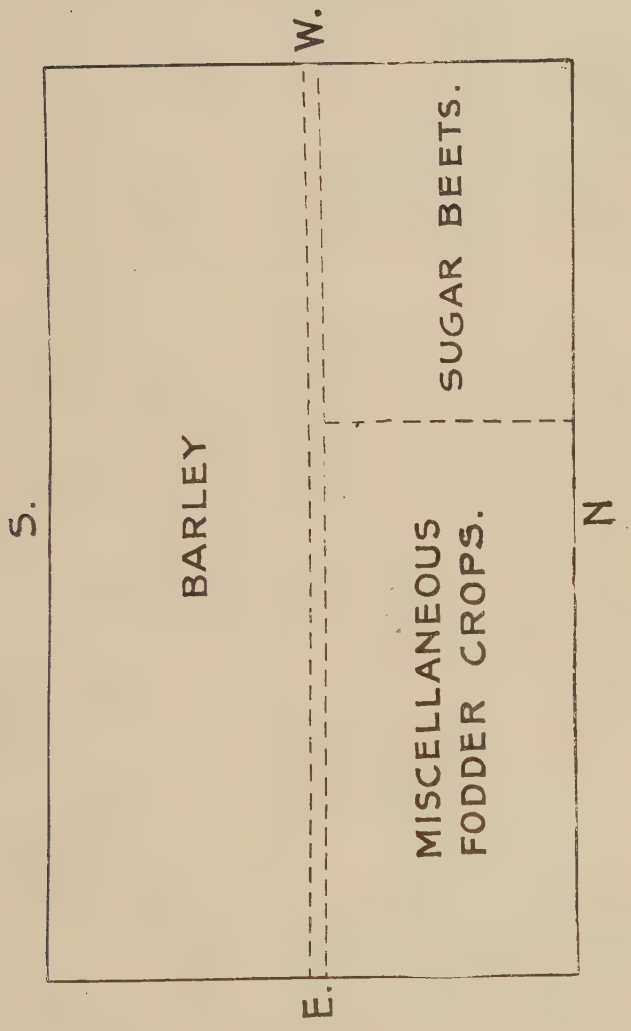
		Pounds.
I.	Florimond Desprez's richest,	760
II.	Bulteau Desprez's richest,	760
III.	Dippe's Kleinwanzleben,	705
IV.	Dippe's Vilmorin,	680
V.	Simon Le Grand's white improved,	865
	Total,	3,770

1

2

3
4
5

FIELD "C" 1890.



SCALE, 4 RODS TO INCH.

The majority of the roots were of a smaller size than usual. The quality of some varieties proved to be fair; others have but little value for the production of sugar, as will be seen from the analyses farther on.

The importance of a reliable seed, a good preparation of a deep soil, a proper system of fertilization, a close planting, and a subsequent careful mode of cultivation for the successful production of sugar beet roots fit for an economical manufacture of sugar, has been abundantly illustrated by the writer, by a series of field experiments upon the college farm, as far back as 1873–1876. (See Massachusetts Agricultural College reports for those years.)

Field D.

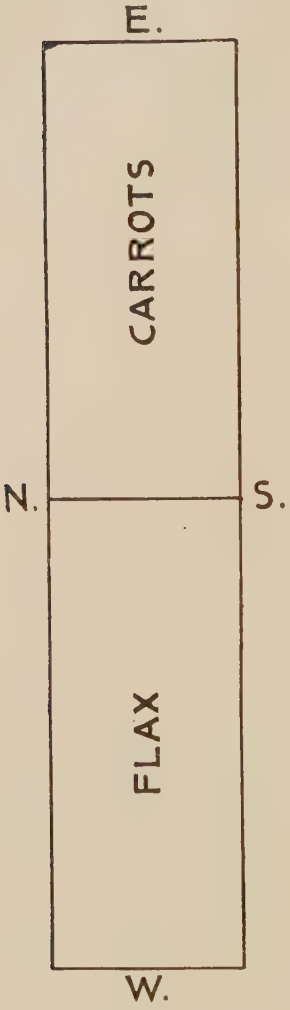
It comprises an area 328 feet long and 70 feet wide, equal to 22,960 square feet, running from east to west, parallel with Field C, with a grass road twelve feet in width between them. Mode of manuring and preparation of the soil previous to seeding corresponds with that described in connection with Field C. The eastern half of the land was planted with carrots, the western with flax.

Flax (*Linum usitatissimum*). — About one-fourth of an acre was sown with flax-seed May 23. Forty-four pounds of seed were used for that purpose. The seed was applied broadcast in two directions, to secure a close stand of the crop. The young plants showed themselves above ground May 29. The crop was weeded by hand June 30. It began to bloom July 2, and reached a height of two feet August 1. As soon as the color of the plants changed decidedly into a greenish-yellow tint, they were pulled, to secure a valuable straw. The seeds were but partly matured. The entire crop when harvested weighed 1,510 pounds. The seed heads were taken off by means of an iron comb, and the straw set up out of doors to dry. The dried straw weighed 670 pounds, August 22. This weight corresponds to 2,570 pounds per acre.

The entire crop was sent to a New York company, according to a previous arrangement, to be converted, by a new process of bleaching, etc., into linen goods, to test its quality for that purpose.

Carrots (*Daucus carota*), *Danvers Yellow.* — The seed was planted by means of a brush-seeding apparatus, using the plate third in size from the smallest, in rows two feet apart, to allow the use of a one-horse cultivator for cleaning, etc., May 9. The crop was subsequently thinned out July 16, and weeded twice by hand. The roots were pulled October 15. They were left for several days in the field in piles, covered with the tops of the roots, before hauling them in. The yield amounted to somewhat over four tons, equal to from sixteen to seventeen tons of carrots per acre.

FIELD "D" 1890.



SCALE, 4 RODS TO 1 INCH.

Sugar Beets.

[From station grounds.]

1. Florimond Desprez's richest sugar beet.
2. Bulteau Desprez's richest sugar beet.
3. Dippe's Kleinwanzleben.
4. Dippe's Vilmorin.
5. Simon Le Grand's white improved.

	Date of Test.	Sugar by Polariscope.	Sugar by Fehling's Test.	Degrees Brix.	Specific Gravity of Juice.	Moisture at 100°C.
		Per Cent.	Per Cent.			
1, Sugar beet,	October 29,	11.92	11.95	–	–	82.13
2, Sugar beet,	October 30,	11.66	11.55	–	–	83.19
3, Sugar beet,	October 29,	12.25	12.09	–	–	81.63
4, Sugar beet,	October 30,	11.76	11.69	–	–	83.15
5, Sugar beet,	October 31,	9.74	9.52	–	–	85.04
		Sugar in Juice.	Sugar in Beets.			
		Per Cent.	Per Cent.	Juice.	Juice.	
1, Sugar beet,	November 10,	13.08	–	16.50	1.06783	–
2, Sugar beet,	November 11,	13.16	12.42	17.04	1.07002	–
3, Sugar beet,	November 10,	14.30	13.10	17.30	1.07133	–
4, Sugar beet,	November 10,	12.75	12.26	15.70	1.06436	–
5, Sugar beet,	November 11,	13.42	12.67	16.60	1.06827	–

Lotus Villosus.

[Collected June 21, 1889; in full bloom. (Field D.)]

	Per Cent.
Moisture at 100° C.,	10.68
Dry matter,	89.32
	100.00

Analysis of Dry Matter.

Crude ash,	8.23
" cellulose,	24.48
" fat,	3.00
" protein (nitrogenous matter),	13.49
Non-nitrogenous extract matter,	50.80
	100.00

Fertilizing Constituents of Lotus Villosus.

	Per Cent.
Moisture at 100° C.,	10.680
Calcium oxide,	1.579
Magnesium oxide,	0.336
Ferric oxide,	0.076

Fertilizing Constituents of Lotus Villosus — Concluded.

	Per Cent.
Sodium oxide,	0.365
Potassium oxide,	2.064
Phosphoric acid,	0.688
Nitrogen,	1.930
Insoluble matter,	0.888
Valuation per ton,	$9 13

Sulla (Hedysarum coronaria).

[Collected June 11, 1889; in full bloom. (Field D.)]

	Per Cent.
Moisture at 100° C.,	8.32
Dry matter,	91.68
	100.00

Analysis of Dry Matter.

Crude ash,	9.87
" cellulose,	28.95
" fat,	2.39
" protein (nitrogenous matter),	16.90
Non-nitrogenous extract matter,	41.89
	100.00

Fertilizing Constituents of Sulla.

	Per Cent.
Moisture at 100° C.,	8.320
Calcium oxide,	2.203
Magnesium oxide,	0.321
Ferric oxide,	0.081
Sodium oxide,	0.083
Potassium oxide,	2.314
Phosphoric acid,	0.482
Nitrogen,	2.479
Insoluble matter,	0.240
Valuation per ton,	$10 98

Teosinte.

[Station, 1889. (Field D.)]

	Per Cent.
Moisture at 100° C.,	6.06
Dry matter,	93.94
	100.00

Analysis of Dry Matter.

Crude ash,	6.95
" cellulose,	28.88
" fat,	1.28
" protein (nitrogenous matter),	9.71
Non-nitrogenous extract matter,	53.18
	100.00

Fertilizing Constituents of Teosinte.

	Per Cent.
Moisture at 100° C.,	6.060
Calcium oxide,	1.597
Magnesium oxide,	0.458
Ferric oxide,	0.021
Sodium oxide,	0.109
Potassium oxide,	3.696
Phosphoric acid,	0.546
Nitrogen,	1.460
Insoluble matter,	0.315
Valuation per ton,	$8 76

Japanese Buckwheat.

[Collected June 28, 1889; little past blooming. (Field D.)]

	Per Cent.
Moisture at 100° C.,	5.72
Dry matter,	94.28
	100.00

Analysis of Dry Matter.

Crude ash,	12.36
" cellulose,	36.02
" fat,	2.22
" protein (nitrogenous matter),	10.80
Non-nitrogenous extract matter,	38.60
	100.00

Fertilizing Constituents of Japanese Buckwheat.

	Per Cent.
Moisture at 100° C.,	5.720
Calcium oxide,	3.418
Magnesium oxide,	0.421
Ferric oxide,	0.148
Sodium oxide,	0.349
Potassium oxide,	3.320
Phosphoric acid,	0.850
Nitrogen,	1.629
Insoluble matter,	0.378
Valuation per ton,	$9 38

Small Pea (Lathyrus sativus).

[Collected Sept. 3, 1889. (Field D.)]

	Per Cent.
Moisture at 100° C.,	5.80
Dry matter,	94.20
	100.00

Analysis of Dry Matter

	Per Cent.
Crude ash,	6.30
" cellulose,	32.88
" fat,	1.49
" protein (nitrogenous matter),	16.57
Non-nitrogenous extract matter,	42.76
	100.00

Fertilizing Constituents of Small Pea.

	Per Cent.
Moisture at 100° C.,	5.800
Calcium oxide,	1.373
Magnesium oxide,	0.276
Ferric oxide,	0.138
Sodium oxide,	0.469
Potassium oxide,	1.990
Phosphoric acid,	0.592
Nitrogen,	2.497
Insoluble matter,	1.081
Valuation per ton,	$10.89

Scotch Tares.

[Whole plant, at end of blooming; station, 1890. (Field C.)]

	Per Cent.
Moisture at 100° C.,	15.80
Dry matter,	84.20
	100.00

Analysis of Dry Matter.

Crude ash,	13.76
" cellulose,	30.89
" fat,	1.89
" protein (nitrogenous matter),	22.00
Non-nitrogenous extract matter,	31.46
	100.00

Fertilizing Constituents of Scotch Tares.

	Per Cent.
Moisture at 100° C.,	15.800
Calcium oxide,	1.698
Magnesium oxide,	0.354
Ferric oxide,	0.460
Sodium oxide,	0.238
Potassium oxide,	3.004
Phosphoric acid,	0.815
Nitrogen,	2.964
Insoluble matter,	4.062
Valuation per ton,	$13.61

Carrots.

[Station, 1889.]

	Per Cent.
Moisture at 100° C.,	89.57
Dry matter,	10.43
	100.00

Analysis of Dry Matter.

Crude ash,	8.76
" cellulose,	8.16
" fat,	1.86
" protein (nitrogenous matter),	9.18
Non-nitrogenous extract matter,	72.13
	100.00

Fertilizing Constituents of Carrots.

	Per Cent.
Moisture at 100° C.,	89.570
Calcium oxide,	0.064
Magnesium oxide,	0.025
Ferric oxide,	0.007
Sodium oxide,	0.013
Potassium oxide,	0.472
Phosphoric acid,	0.086
Nitrogen,	0.153
Insoluble matter,	0.027
Valuation per ton,	$1 02

Carrot Tops (1889).

	Per Cent.
Moisture at 100° C.,	9.760
Calcium oxide,	2.089
Magnesium oxide,	0.667
Ferric oxide,	0.118
Sodium oxide,	4.028
Potassium oxide,	4.883
Phosphoric acid,	0.612
Nitrogen,	3.130
Insoluble matter,	0.098
Valuation per ton,	$15 52

Parsnips.

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	80.34
Dry matter,	19.66
	100.00

Analysis of Dry Matter.

	Per Cent.
Crude ash,	7.43
" cellulose,	7.67
" fat,	3.37
" protein (nitrogenous matter),	6.88
Non-nitrogenous extract matter,	74.65
	100.00

Fertilizing Constituents of Parsnips.

	Per Cent.
Moisture at 100° C.,	80.340
Calcium oxide,	0.088
Magnesium oxide,	0.045
Ferric oxide,	0.005
Sodium oxide,	0.006
Potassium oxide,	0.617
Phosphoric acid,	0.187
Nitrogen,	0.217
Insoluble matter,	0.019
Valuation per ton,	$1 50

Barley Straw.

[Station, 1890. (Field C.)]

	Per Cent.
Moisture at 100° C.,	11.44
Dry matter,	88.56
	100.00

Analysis of Dry Matter.

Crude ash,	5.30
" cellulose,	33.85
" fat,	3.38
" protein (nitrogenous matter),	9.24
Non-nitrogenous extract matter,	48.23
	100.00

Fertilizing Constituents of Barley Straw.

	Per Cent.
Moisture at 100° C.,	11.44
Calcium oxide,	0.57
Magnesium oxide,	0.18
Sodium oxide,	0.18
Potassium oxide,	2.09
Phosphoric acid,	0.30
Nitrogen,	1.31
Insoluble matter,	0.24
Valuation per ton,	$6 59

Bokhara Clover.

[Collected June 26, 1890. (Field D.)]

	Per Cent.
Moisture at 100° C.,	8.50
Dry matter,	91.50
	100.00

Analysis of Dry Matter.

Crude ash,	8.41
" cellulose,	33.05
" fat,	4.79
" protein (nitrogenous matter),	14.92
Non-nitrogenous extract matter,	38.82
	100.00

Fertilizing Constituents of Bokhara Clover.

	Per Cent.
Moisture at 100° C.,	8.50
Calcium oxide,	1.63
Magnesium oxide,	0.32
Ferric oxide,	0.02
Sodium oxide,	0.15
Potassium oxide,	1.99
Phosphoric acid,	0.68
Nitrogen,	2.18
Insoluble matter,	0.10
Valuation per ton,	$9 92

Soja Bean.

[Collected Aug. 27, 1890, station; blooming. (Field D.)]

	Per Cent.
Moisture at 100° C.,	74.17
Dry matter,	25.83
	100.00

Analysis of Dry Matter.

Crude ash,	11.05
" cellulose,	24.73
" fat,	7.22
" protein (nitrogenous matter),	13.64
Non-nitrogenous extract matter,	43.36
	100.00

Turnips.

[Experiment Station, 1890.]

	Per Cent.
Moisture at 100° C.,	91.78
Dry matter,	8.22
	100.00

Analysis of Dry Matter.

	Per Cent
Crude ash,	9.54
" cellulose,	12.61
" fat,	2.05
" protein (nitrogenous matter),	9.89
Non-nitrogenous extract matter,	65.91
	100.00
Albuminoid nitrogen (in dry matter),	1.09
Total nitrogen,	1.58

Fertilizing Constituents of Turnips.

	Per Cent.
Moisture at 100° C.,	91.780
Calcium oxide,	0.061
Magnesium oxide,	0.020
Sodium oxide,	0.022
Potassium oxide.	0.358
Phosphoric acid,	0.092
Nitrogen,	0.134
Insoluble matter,	0.038
Valuation per ton.	$0 87

IX. Experiments to study the Economy of using Different Commercial Sources of Phosphoric Acid for Manurial Purposes in Farm Practice. (Field F.)

The field selected for this purpose was 300 feet long and 137 feet wide, running on a level from east to west. Previous to 1887 it was used as a meadow, which was well worn out at that time, yielding but a scanty crop of English hay. During the autumn of 1887 the sod was turned under, and left in that state over winter. It was decided to prepare the field for special experiments with phosphoric acid by a systematic exhaustion of its inherent resources of plant food. For this reason no manurial matter of any description was applied during the years 1887, 1888 and 1889.

The soil, a fair sandy loam, was carefully prepared every year by ploughing during the fall and in the spring, to improve its mechanical condition to the full extent of existing circumstances. During the same period a crop was raised every year. These crops were selected, as far as practicable, with a view to exhaust the supply of phosphoric acid in particular. Corn, Hungarian grass and leguminous crops (cow-pea, vetch and serradella), followed each other in the order stated.

1890. — The land had been ploughed during the preceding fall, and again April 19, 1890. The field was subdivided subsequently into five plats of definite size, each running from east to west. These plats were separated from each other by a space eight feet wide.

The plats and spaces between them were ploughed and harrowed alike. The plats were fertilized at stated times; the spaces which separated them received at no time any kind of manurial matter.

The manurial material applied to each of these five plats contained, in every instance, the same form and the same quantity of potassium and of nitrogen, while the phosphoric acid was furnished in each case in the form of a different commercial phosphoric-acid-containing article; namely, phosphatic slag, Mona guano, apatite, South Carolina phosphate

(floats), and dissolved bone-black. The market cost of each of these articles controlled the quantity applied, for each plat received the same money value, in its particular kind of phosphate.

	Cost per Ton.
Phosphatic slag,	$15 00
Mona guano (West Indies),	15 00
Ground apatite (Canada),	6 25
South Carolina phosphate (floats),	15 00
Dissolved bone-black,	25 00

Analyses of Phosphates used.

[I. Phosphatic slag; II. Mona guano; III. Apatite; IV. South Carolina phosphate (floats); V. Dissolved bone-black.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	0.47	12.52	0.09	0.39	15.96
Ash,	–	75.99	–	–	61.46
Calcium oxide,	46.47	37.49	–	46.76	–
Magnesium oxide,	5.05	–	–	–	–
Ferric and aluminic oxides,	14.35	–	–	5.78	–
Total phosphoric acid,	19.04	21.88	36.08	27.57	15.82
Soluble phosphoric acid,	–	0.00	–	0.00	12.65
Reverted phosphoric acid,	–	7.55	–	4.27	2.52
Insoluble phosphoric acid,	–	14.33	–	23.30	0.65
Insoluble matter,	4.39	2.45	9.55	9.04	6.26

The following fertilizers were applied to the different plats April 17, 1890: —

Plat I. (south side), 6,494 square feet,
- 127 pounds of ground phosphatic slag.
- 43 pounds of nitrate of soda.
- 58 pounds of potash-magnesia sulphate.

Plat II., 6,565 square feet,
- 128 pounds of ground Mona guano.
- 43½ pounds of nitrate of soda.
- 59 pounds of potash-magnesia sulphate.

Plat III., 6,636 square feet, . { 304 pounds of ground apatite.
44 pounds of nitrate of soda.
59 pounds of potash-magnesia sulphate.

Plat IV., 6,707 square feet, . { 131 pounds of South Carolina phosphate.
44½ pounds of nitrate of soda.
60 pounds of potash-magnesia sulphate.

Plat V., 6,778 square feet, . { 78 pounds of dissolved bone-black.
45 pounds of nitrate of soda.
61 pounds of potash-magnesia sulphate.

The phosphatic slag, Mona guano and South Carolina floats were applied at the rate of 850 pounds per acre, apatite at the rate of 2,000 pounds per acre; dissolved bone-black at the rate of 500 pounds per acre. These figures represent approximately the equal local cash values of the different sources of phosphoric acid applied. Nitrate of soda corresponds in all cases to an application of 290 pounds per acre, and the potash-magnesia sulphate at the rate of 390 pounds per acre.

The field was planted with potatoes, Beauty of Hebron; the large-sized ones were cut in halves, and the small ones left whole, when planted, May 1, 1890. The rows were three feet three inches apart, and the hills in the rows eighteen inches. Each plat had sixteen rows. The young plants came up quite uniformly; they were cultivated and hoed June 2. Several applications of Paris green with plaster were made during the season, to prevent damage by potato bugs. The crop looked well until the middle of July, when the effects of a serious drought showed itself to such an extent that the maturing seemed to be hastened on by it.

The potatoes were harvested from all the plats August 12 to 14. They were assorted in the field into marketable ones and small ones. The former were sold at sixty cents per bushel; the latter were used for chicken feed, at twenty cents per bushel, — our local market prices.

No. of Plat.	Total Yield of Potatoes (Pounds).	Marketable Potatoes (Pounds)	Small Potatoes (Pounds)
I. (south end),	1,600	1,215	385
II.,	1,415	915	500
III.,	1,500	1,070	430
IV.,	1,830	1,380	450
V. (west end),	2,120	1,590	530

Yield per Acre.

I.	Phosphatic slag,	10,671	8,087	2,584
II.	Mona guano,	9,388	6,071	3,317
III.	Ground apatite,	9,845	7,023	2,822
IV.	South Carolina phosphate,	11,886	8,963	2,923
V.	Dissolved bone-black,	13,626	10,218	3,408

Statement of Percentages.

Plats.	Marketable Potatoes (Per Cent).	Small Potatoes (Per Cent).
I.,	75.78	24.22
II.,	64.66	35.34
III.,	71.32	28.68
IV.,	75.40	24.60
V.,	74.91	25.09

Money Value of Crop.

[One bushel = 60 pounds.]

Plat.	Marketable Potatoes, at 60 Cents per Bushel.	Small Potatoes, at 20 Cents per Bushel.	Total Sum.
I.,	134.6 bushels = $80 76	43.0 bushels = $8 60	$89 36
II.,	101.2 bushels = 60 72	55.3 bushels = 11 06	71 78
III.,	117.1 bushels = 70 26	47.1 bushels = 9 42	79 68
IV.,	149.3 bushels = 89 58	48.7 bushels = 9 74	99 32
V.,	170.3 bushels = 102 18	56.8 bushels = 11 36	113 54

As a first year's results, the above statements are reported without any further comment, beyond the remark that the dryness of the season renders the advantages of a soluble form of phosphoric acid very striking. The experiment will be repeated during the coming season. Winter wheat has been sown, to continue the inquiry. One year's results cannot furnish a basis for a final decision. The varying accumulation of phosphoric acid in the soil is an important fact, which deserves a serious consideration as the investigation advances.

Plat I. received 24.18 pounds of phosphoric acid.
Plat II. received 28.01 pounds of phosphoric acid.
Plat III. received 109.68 pounds of phosphoric acid.
Plat IV. received 36.12 pounds of phosphoric acid.
Plat V. received 12.34 pounds of phosphoric acid.

The largest yield of potatoes has only removed 3.392 pounds of phosphoric acid from the soil.

Tabular Statement of the Approximate Amount of Nitrogen, Phosphoric Acid and Potash in the Crop raised.

PLATS.	Pounds of Potatoes per Plat.	Pounds of Nitrogen in Tubers.	Pounds of Phosphoric Acid in Tubers.	Pounds of Potassium Oxide in Tubers.
I., ...	1,600	5.440	2.560	9.280
II., ...	1,415	4.811	2.364	8.207
III., ...	1,500	5.100	2.400	8.700
IV., ...	1,830	6.222	2.928	10.614
V., ...	2,120	7.208	3.392	12.296

The calculation is based on E. Wolff's average analyses, 1,000 pounds of potatoes containing: nitrogen, 3.4 pounds; phosphoric acid, 1.6 pounds; and potassium oxide, 5.8 pounds.

X. Experiments with Grass Land, East Field Meadow.

The field assigned for a permanent production of grasses covers an area of from nine to ten acres. The main part of the land is nearly on a level, running from south to north, with a slight descent towards the north. The western side of the field is bordered by a public highway, the eastern by the new orchard of the station. Along the eastern side the grounds are gently sloping towards the centre of the field, and are here and there somewhat springy. The location of the level portion of the field renders it liable to a temporary overflow of water from the hillsides toward the south.

The soil consists largely of a sandy loam of from two to three feet in thickness, here and there resting upon either a layer of hard-pan or of a coarse, gravelly material.

The springy character of the eastern slope, as well as the periodical overflow of water from the hillsides toward the southern end of the field, without any adequate outlet to regulate the supply of water from both sources, had rendered the larger portion of the field an unsightly swamp meadow, covered with a comparatively worthless vegetation, previous to 1887.

The general character of the surface soil, as well as the apparent chances of regulating its state of moisture, promised to make the field, under proper management, in an exceptional degree fit for a permanent meadow.

The first attempt at improvement in that direction was made in August, 1886, soon after the first cut of its growth was harvested. The entire work required to secure satisfactory results was carried out during two succeeding summer seasons, on account of limited financial resources.

After securing the outlet necessary for the accumulating water, through the adjoining lands at the western termination of the field, it was decided to run, from ten to twelve feet apart, two parallel ditches from north to south, through the lowest part of the land. One was dug from three and one-half to four feet below the surface of the ground, to serve as a main ditch for laying drain tiles six inches in diameter, to prevent an accumulation and subsequent stagnation of water

in the upper soil. The other was an open ditch, on an average of from one foot to eighteen inches deep, to assist in a speedy discharge of surface water, due to heavy rains or the melting of the snow and ice on adjoining hillsides in the spring. In both instances the necessary fall was secured to dispose of the surplus water in a desirable degree. One surface ditch sufficed for the whole area; while numerous branch ditches, starting out from the main tile ditch at varying distances from each other, were built at all places where local conditions indicated an exceptional state of moisture. The tiles in the branch drain ditches varied from two to four inches in diameter. The main tile drain at its southern starting point runs into a stone drain ten by twenty feet, which serves as a filter for the turbid water coming from the adjoining hillsides in case of heavy rains before entering the tile drain. The surface ditch runs up to the stone drain to prevent an accumulation of water, and thereby reduces the chances of untimely overflow of the meadow.

As soon as the drain tiles were covered and the ditches as far as practicable levelled, the entire area was ploughed, and the main depressions filled up with stones and earth, or earth, as circumstances advised, and left in that condition over winter.

The succeeding spring a wheel harrow was used to break up the rotten sod. The soil was subsequently repeatedly ploughed and harrowed, until it showed the desirable mechanical condition required for a successful cultivation of summer grain crops.

Barley and oats were chosen as the first crops in case of the meadow north of the new roadway. Both were seeded in drills, with rows two feet apart, to permit a thorough destruction of an objectionable foul growth, by a frequent use of the cultivator and hoe.

As soon as these crops were harvested, one ton of wood ashes per acre was ploughed in, to assist in the disintegration of the excess of organic peaty matter, and to serve as a general fertilizer. Ploughing once more and smoothing the surface by means of a brush harrow, the entire area was seeded down into grass to serve as meadow. The latter was

subsequently cut into two, by a road built for communication to more remote fields. This arrangement caused a division into a northern and southern meadow.

In case of the land south of the roadway, leguminous plants, as soja bean, Southern cow-pea and serradella, served as first crop. The system of drainage and of seeding down remained the same as before. The meadow north of the road covers an area of somewhat more than six acres, and that south of the road is about three acres in size. The meadow north of the road was sown for the first time in the fall of 1887, with grass, and the one south of the roadway in the fall of 1888.

The more elevated portions of both were seeded down with the following mixture of grass seeds, at the rate of from two to two and one-half bushels per acre: —

Two bushels herds grass (*Phleum pratense*).
Two bushels red top (*Agrostis vulgaris*).
Two bushels Kentucky blue-grass (*Poa pratensis*).
Two bushels meadow fescue (*Festuca pratensis*).
Seven pounds sweet-scented vernal grass (*Anthoxanthum odoratum*).

Early in the succeeding spring a mixture of equal weights of medium red clover and alsike clover was added broadcast, at the rate of from five to six pounds per acre.

The lower and still more wet portion of the meadow was seeded down with the following mixture of grass seeds: —

Twenty pounds of soft brome grass (*Bromus mollis*).
Twelve pounds herds grass (*Phleum pratense*).
Nine pounds red fescue (*Festuca rubra*).
Eight pounds fowl meadow grass (*Poa serotina*).
Seven pounds Rhode Island bent (*Agrostis alba*).
Six pounds orchard grass (*Dactylis glomerata*).
Five pounds crested dog-tail (*Cynosurus cristatus*).
Four pounds meadow soft grass (*Holcus lanatus*).
Two pounds sweet-scented vernal grass (*Anthoxanthum odoratum*).

From four to five pounds of alsike clover per acre were added by broadcast seeding early in the succeeding spring (1889).

The seed came up well, and suffered but here and there in wet spots during the first winter. Barren spots were reseeded.

Both meadows were cut but once during the first summer season, somewhat later than usual; the majority of grasses did not, as might be expected, head out.

As soon as the first crop of hay was secured, a system of manuring was planned, which would illustrate the comparative manurial effect of top-dressing, as follows: —

By barn-yard manure.
By ground bones and muriate of potash.
By unleached wood ashes.

The northern meadow, consisting of six and one-half acres, was subdivided into three plats, I., II., III., running from east to west, leaving a space of twenty feet in width between them without any manurial matter.

The southern meadow was divided into two plats, IV., V. (south end). Plats I., II., III. were sown down in grass during September, 1887, and plats IV. and V. during September, 1888. The subsequent stated system of manuring began in the autumn of 1888, on all plats at the same time.

Plat I. (north end of the field) is equal to 1.92 acres. It was top-dressed during the fall and early spring with barn-yard manure, at the rate of eighteen tons per acre (1888–89).

Plat II. covers a similar area as Plat I. (83,640 square feet). It received at the same time a top-dressing of barn-yard manure, at the rate of eight tons per acre (1888). The coarsest part of the barn-yard manure was subsequently removed from both plats before the growing grass interfered with its being raked off.

Plat III., about 2.41 acres, received, May 3, 1889, a top-dressing of six hundred pounds of fine-ground steamed bone and two hundred pounds of muriate of potash per acre.

Plat IV. (south of roadway), an area of 2.11 acres, received the same dressing, in the same proportion and at the same rate (six hundred pounds ground bone and two hundred pounds muriate of potash) per acre, as Plat III. (1889).

Plat V., equal to .91 acres, received as top-dressing, April 23, 1889, one ton of unleached Canada wood ashes, from our local market (1889).

Yield of Hay in Case of Plats I., II. and III. (Second Year after Seeding), and of Plats IV. and V. (First Year after Seeding).

Plat I.	First Cut.	Second Cut.
1.92 acres, . .	10,500 pounds, June 24.	4,370 pounds, August 26.

Total yield per acre, 7,745 pounds, or 3.87 tons.

Plat II.	First Cut.	Second Cut.
1.92 acres, . .	9,130 pounds, June 24.	4,650 pounds, August 26.

Total yield per acre, 7,177 pounds, or 3.59 tons.

Plat III.	First Cut.	Second Cut.
2.41 acres, . .	12,200 pounds, June 24.	4,950 pounds, August 26.

Total yield per acre, 7,116 pounds, or 3.56 tons.

Plat IV. (2.11 acres); Plat V. (.91 acres): The first year's hay consisted nearly entirely of herds grass, which was almost the only variety which had headed out in June. The yields of both plats were harvested together.

First Cut.	Second Cut.	Total Yield per Acre.
8,130 pounds, June 24.	3,105 pounds, August 31.	3,720 pounds, or 1.86 tons.

1890. — The different plats were prepared in a similar manner for the season of 1890 as they had been for the preceding season, 1889.

Plats I. and II. received a top-dressing of barn-yard manure during the months of October and November; the former

at the rate of fourteen tons per acre, and the latter at the rate of eleven tons.

Plat III. was treated in April, 1890, as before, with a mixture of six hundred pounds of fine-ground bones and two hundred pounds of muriate of potash.

Plats IV. and V. were merged into one plat, and received a top-dressing of unleached wood ashes, at the rate of one ton per acre, April 19, 1890.

Barren spots in this plat, it being the second year after seeding down, were reseeded by the same seed mixture which had been used before.

The entire meadow received an addition of from two to three pounds of alsike clover seed, broadcast, per acre.

All plats were cut as far as practicable at the same time.

Yield of Hay in 1890.

Plat I.	First Cut.	Second Cut.
1.92 acres, . .	14,625 pounds, July 1.	3,790 pounds, Sept. 1.

Total yield of hay, 18,415 pounds.
Yield per acre, 9,591 pounds, or 4.80 tons.

Plat II.	First Cut.	Second Cut.
1.92 acres, . .	12,480 pounds, July 1.	3,105 pounds, Sept. 3.

Total yield of hay, 15,585 pounds.
Yield per acre, 8,117 pounds, or 4.06 tons

Plat III.	First Cut.	Second Cut.
2.41 acres, . .	14,460 pounds, June 26.	3,535 pounds, September.

Total yield of hay, 17,995 pounds.
Yield per acre, 7,466 pounds, or 3.73 tons.

Yield of Hay in 1890 — Concluded.

Plat IV. (IV. and V., 1889.)	First Cut.	Second Cut.
3 acres, . .	13,380 pounds, July 1.	4,080 pounds, Sept. 3.

Total yield of hay, 17,460 pounds.
Yield per acre, 5,820 pounds, or 2.91 tons

The total yield of hay on plats I., II. and III. averages 4.19 tons per acre. The total yield on Plat IV. averages 2.91 tons per acre.

The weight of the second cut of hay (rowen) averages about one-fourth of that of the first cut. The dryness of the season during the latter part of July affected seriously the yield of the second cut. The wet season of 1889, as compared with the dry season of 1890, as well as the difference in the age of the two meadows, renders further comparison not advisable at this early stage of our investigation.

XI. Report on General Farm Work.

Aside from the experimental work described within the preceding pages, much has been accomplished in other directions.

Some of this work is of a mere preparatory character, and will be reported in due time in connection with a detailed description of the experiment with which it is connected. The remainder concerns merely current farm work, as may be seen from a few subsequent statements.

The new orchard, covering an area of from six to seven acres, has been in part planted with apple, pear, peach and plum trees; other varieties, as well as small fruits, will be planted during the coming spring.

Several acres were sown with vetch and oats, soja bean and corn, to furnish green fodder for the dairy, and to serve as ensilaged crops for winter feed.

One silo is filled with fodder corn, and another with half soja bean and half fodder corn.

It has been the aim to improve the productiveness of the farm lands, wherever circumstances admitted a free choice of suitable means. To produce a variety of fodder crops has been the leading object of the general management.

The subsequent statement contains an enumeration of the principal crops raised in different parts of the farm, on lands either permanently assigned for the production of fodder for the live stock of the station, or engaged in a course of preparation for future experiments: —

Hay (first cut),	46½	tons.
Rowen (second cut),	12½	"
Fodder corn,	5½	"
Roots (carrots, 4½ tons; sugar beets, 3 tons),	7½	"
Scotch tares (dry),	1⅓	"
Barley (grain, 430 pounds; straw, 1,200 pounds),	⅘	"
Oats (grain, 1,250 pounds; straw, 2,000 pounds),	1⅘	"
Vetch and oats (green),	4	"
Soja bean (green),	10	"
Corn for ensilage,	18	"
Potatoes,	190	bushels.
Flax,	670	pounds.
Miscellaneous fodder crops,	1½	tons.

XII. Department of Vegetable Physiology.

Report by Prof. James Ellis Humphrey.

The past year has seen the department finally settled in the new quarters provided for it, and fairly equipped for work. Owing to repeated delays, the new laboratory was not occupied until the middle of March, and the greenhouse was completed so late that it did not become practically available until fall. Therefore the present contains no reports of greenhouse work. What has been done the past fall consists of preparations for and the beginnings of experiments not yet completed, and is reserved until results can be reported.

The work of the past year here reported upon consists of laboratory and field studies of several diseases which cause very severe losses to farmers and fruit growers, or of the fungi which cause them, as follows: —

1. The black knot of the plum.
2. The mildew of cucumbers, etc.
3. The brown rot of stone fruits.
4. The potato scab.
5. Notes on various diseases.

Reference to the "General Account of the Fungi," in the last report of this station, will be found of assistance to a full comprehension of the following discussions.

The Black Knot of the Plum. — *Plowrightia morbosa* (Schw.) Sacc.

For a hundred years complaints have come from one or another part of the United States of the destruction of plum and cherry trees through the attacks of a conspicuous and fatal disease, which shows itself in the formation of dark, rough excrescences upon the limbs or even on the trunk of the tree.

These growths increase both in size and in number, spreading from branch to branch and from tree to tree, in a manner strongly suggesting their contagious nature; and

their striking appearance has given to the disease the name by which it is too well known, "the black knot," or "plum wart."

The cause of this disease has been the subject of much discussion and of innumerable contributions to agricultural journals, from an early date. Some of the first remarks on the subject are to be found in an article by Prof. W. D. Peck of Cambridge.* The appearance of the knot is here attributed to the same insect which causes the falling of the fruit, now called the "curculio." This insect was believed to injure the branch in such a way that, as the writer says, the sap is diverted to the bark, which absorbs it and swells, forming the knots. The general theory here promulgated, that of an *insect* cause, was for over fifty years very tenaciously held and earnestly supported, and indeed is still held by many persons, although wholly discredited by scientific study. The fact that eggs or larvæ of the curculio are very commonly found in the tissue of the knot has been a strong argument with many in support of Peck's theory; but others, while holding to the general belief in an insect cause, have believed the knots to be due to some species of gall fly (*Cynips*), since none of the beetles, including the curculio, are known to be gall-producing insects. Thus argued the entomologist, B. D. Walsh, in an early paper.† But the difficulty here lies in the fact that no gall fly has been found in or raised from a knot.

Several writers have attributed the trouble to that conveniently indefinite cause, — a diseased condition of the sap; and Dr. Fitch, the former New York State Entomologist, held the disease to be of internal, "constitutional" origin. Quite early, Dr. Joel Burnett of Southborough discussed ‡ the question, showed that the curculio merely lays its eggs in the juicy mass of the knot, after it is formed, and attributed its formation to the attacks of a fungus. This is, perhaps, the earliest statement of this

* Mass. Agric. Repository, 1819, p. 307.

† Proceedings Entomol. Soc. Philadelphia, Vol. III, p. 613 (1864).

‡ Hovey's Mag. of Hortic., Vol. IX, p. 281; and N. E. Farmer, 16 Aug., 1843, p. 49.

view in a popular form, although the knots and the accompanying fungus had already been described by the pioneer student of American fungi, de Schweinitz, who appears to have regarded the knots as the combined result of the attacks of a gall fly and the fungus, to which he gave the name *Sphæria morbosa*.* In 1831 he described, in his "*Synopsis Fungorum in America Boreali media digentium*," the destruction of both wild and cultivated varieties by the disease. The distinguished entomologist, Dr. T. W. Harris, in his earlier writings advocated the view that the knot is caused by insects; but later † he mentions the fungus, which, he says, is sure to appear on the knots, and never elsewhere, though he does not commit himself fully to the theory that the disease is of fungous origin. In 1862 the editor of the "Gardener's Monthly," Mr. Thos. Meehan, took strong ground in favor of the fungous origin of the disease, and for several years following a spirited discussion of the subject was carried on by various correspondents in the columns of his journal. At about the same time it was logically argued, in the "Country Gentleman," that, even though insects were found in ninety-nine knots, the finding of the hundredth one free from them would be sufficient to show that they could not be the *cause* of the disease.

Mr. C. F. Austin gave ‡ what appear to have been the first account and illustrations of the microscopic structure of the knot fungus. Entomological writers now began rapidly to accept the fungus theory of the origin of the knots, as is shown by papers from Glover,§ Walsh‖ and Riley.¶ Walsh gives at considerable length an account of the supposed structure and life history of the knot fungus, so wholly unlike what we now know of it that it is impossible to conjecture what he could have seen. Up to 1872 knowledge of the fungus was very meagre, and confined to the winter spores to be described later. In that year Prof.

* Synopsis Fungorum Carolinæ superioris, no. 134 (1821).
† Insects Injurious to Vegetation, 2d ed., p. 69 (1852).
‡ Amer. Agriculturist, 1863, p. 113.
§ U. S. Agric. Report, 1863, p. 572.
‖ Practical Entomologist, Vol. I, p. 48, and Vol. II, p. 63 (1866-67).
¶ Gardener's Monthly, November, 1866, p. 331.

C. H. Peck, New York State Botanist, gave the first correct account * of some details of the structure of *Sphæria morbosa*, then first describing the summer spores and the time of maturity of the winter spores. In 1875 Dr. Thos. Taylor gave † an illustrated account of the fungus, which was incomplete and incorrect in several particulars, and added nothing to previous knowledge.

Now followed the fullest and best account we have of the structure and life history of this fungus, which was held to be the sole cause of black knot. It was by Dr. W. G. Farlow ‡ of Harvard University, and remains the authoritative account of the disease and its cause, to-day. The author described the summer and winter spores, and, as will be noticed later, other secondary forms, and figured the various organs. This paper has served as the basis of the present, as it must of all work on the black knot; but its comparative inaccessibility renders the repetition of certain descriptions and illustrations not superfluous in connection with the new facts to be presented here. Since its publication, the authority of this paper as to the cause of the disease has remained unquestioned, and all conflicting theories have fallen into discredit among scientific students and observers.

The black knot is known to attack nearly all our wild or cultivated species of plums and cherries; but, so far as the cultivated fruits are concerned, the plums are by far the greater sufferers. It has been thought there must be two or more species of fungi which produce the knots on different host-species. Walsh, for instance, considered that there are two fungi, one attacking the plum and the other the cherry; and a reviewer of his paper suggested a third on a species of wild plum. Others have based arguments for this opinion chiefly on the fact that certain hosts sometimes suffer from epidemics of the black knot, while others, equally liable to its attacks, remain free.§ De Schweinitz

* A Paper on Botany, read as a Report before Albany Inst., Feb. 6, 1872.

† Monthly Micros. Journal, Vol. XIII, p. 118, with two plates; London, March, 1875.

‡ Bulletin Bussey Institution, Part V, p. 440, with three plates (1876).

§ See Gardener's Monthly, November, 1866, p. 335.

has mentioned * an instance of the sort as having occurred at Bethlehem, Penn. Soon after 1790, the very abundant trees of what he calls "Amarellæ," probably morello cherries, were nearly all destroyed by the knot; while a second visitation, about 1830, swept off most of the plum trees. Many farmers and fruit growers will recall similar cases in their own experience. In spite of these facts, however, there is no evidence that there is more than a single species of knot fungus, which attacks both plums and cherries; and we must probably seek other causes for its occasional selection of particular hosts, to the exclusion of others equally susceptible.

As has been the case with many cultivated plants, certain varieties of plums have been claimed by originators or dealers to be disease-proof. As early as 1843, Messrs. W. R. Prince and Co., nurserymen of Flushing, N. Y., published in the "New England Farmer" a list of varieties claimed by them to be not subject to the black knot, with the remark that they were all varieties of American origin. A few months later, a brief editorial note in the same paper stated, on the authority of prominent growers, that the list was of no value for the vicinity of Boston. And similar claims have usually met a similar fate.

This fungus is strictly American in origin, and has not yet, so far as has been reported, been introduced with its host plants into Europe, as have so many other American fungi. But in the United States it is very widely distributed, ranging from Maine to California, and from Wisconsin to Texas, where it is said to be rare. In most parts of the country it is abundant and destructive.

As above stated, the fungus was first described and named as *Sphæria morbosa* Schw. Various writers have proposed various other generic names as better indicating its relationships, but none of these was generally adopted until Saccardo, regarding it as a member of the family *Dothidaceæ* of the "Black Fungi" (*Pyrenomycetes*), called it *Plowrightia morbosa* (Schw.) Sacc., by which name it is now commonly known.

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* Synopsis Fungorum Amer. Bor. Proc. Amer. Phil. Soc., Vol. III, p. 269.

The knot may first be observed in the fall as a slight swelling of the branch, arising near an old knot, or independently. If near a knot, it is probably caused by the extension of vegetative threads from the latter; but, if on a branch not before attacked, it is probably due to infection by spores from an earlier knot. A section across such a young knot shows that the swelling has taken place wholly in the bark and largely in the inner bark (Phloëm), in which may be seen radially placed bundles of the fine, intertwined threads of the fungus. The swelling continues in the spring, and the epidermis ruptures, allowing the protrusion of the dark, greenish-brown mass of tissue, presumably due to abnormal growth induced by the irritation caused by the presence of the fungus. This mass is firm and succulent, and its surface is usually irregularly cracked and granular. In May there are developed over this surface numerous short, erect threads, standing rather closely together, like the threads in the "pile" of velvet, and giving to the surface a dark-brown, velvety appearance. On these threads are borne, at and near their tips, the summer spores of the fungus, obovate bodies of a brownish tint. (Fig. 6.)

Toward midsummer these threads and spores disappear, and, in consequence, the knot loses its velvety appearance and brownish shade, and becomes dead black in color. It also becomes hard and dry, and the larvæ of insects whose eggs were laid in it when it was young and juicy have already begun to destroy its interior, so that very often only the outer crust finally remains. In this fact is to be found the basis of the stoutly defended theories of the insect origin of the knot already alluded to. The surface of the knot may now be seen to be checkered off into little rounded areas, each of which has a slight depression at the centre. In some cases, these black areas do not completely cover the surface, but leave intervening brown spaces. If a section be made across the knot in the fall, a year after its first appearance, under each of the black areas described may be seen with the unaided eye a white spot, which marks the position of a cavity in the dense, black fungus-tissue. This is filled with slender, colorless

threads, as the microscope shows. Later, there appear in these cavities, among the slender threads, club-shaped structures, in each of which are gradually developed eight colorless winter spores, which become ripe and capable of germination by the middle of January. Crozier gives * a considerably later date for the maturity of the spores in Michigan; but the above, given by Dr. Farlow for eastern Massachusetts, has been found by the writer to be also correct for Amherst. These spores may continue in the cavity for some time, but eventually escape, probably by a pore formed at the central depression before mentioned.

A fully developed knot ordinarily shows no spores remaining by late spring or summer.

Fig. 1 shows a magnified section through three of the spore cavities or *perithecia* of the fungus, containing the club-shaped spore-sacs or *asci*. In Fig. 2 are represented two spore-sacs, with their contained spores, and two of the sterile threads or paraphyses among which they grow.

When obtaining the winter spores in quantity by scraping the freshly cut surface of a section across many perithecia, I have nearly always found mixed with them a small proportion of the globular or slightly elliptical brownish bodies shown at Fig. 4, *a*; but I have not yet met with them in spore cavities.

Studies of the development of the three above-described spore forms have been carried on in the laboratory with interesting results. The following account gives a general outline of the progress and present status of the work. After its completion, a detailed account of the investigations, with their results, both theoretical and practical, will be published, with full illustrations, in a suitable form.

The winter spores, when sown in water and kept in a moist chamber, begin to germinate so promptly that they show germ tubes of some length at the end of one day (Fig. 3, *a*); while in two days as many as three threads, one of which has taken the lead, as a rule, and has become several times as long as the spore, may have developed (Fig. 3, *b*). The principal threads usually originate from

* Botanical Gazette, 1885, p. 368.

the larger of the two spore cells, though in exceptional cases one from the smaller cell may take the lead (Fig. 3, *b*). The threads may originate from any point on the surface of either cell.

The brown spores which occur with the winter spores germinate even more promptly than the latter, and may produce in two days threads whose length is ten or fifteen times the diameter of the spores (Fig. 4, *c*).

When sown on nutrient gelatine, prepared with an infusion of prunes, and kept in a moist chamber at the ordinary temperature of the laboratory, the winter spores produce abundant threads, which grow and branch rapidly, forming a close felt, which begins, in four or five days, to show a dark fuscous-brown tint. This color deepens and spreads, and there arise on the threads, in six or seven days, small black bodies, projecting somewhat above the surface of the gelatine. These present, when viewed under the microscope, from above, the appearance shown in Fig. 9, from which it will be seen that their exterior is composed of a close layer of angular cells, interrupted in the middle and highest part by an opening or mouth, which is fringed by a circle of radiating threads. It may be observed that spores escape from the interior of the body through this mouth in the form of a long, snake-like thread or *cirrhus*, consisting of innumerable spores, imbedded in a transparent, gelatinous substance. If a portion of this thread be placed in water, it becomes disintegrated by the rapid swelling and solution of its gelatinous basis, thus leaving the spores free. These bodies, which are evidently reproductive organs of the type known as *conidial fruits*, are of an approximately globular form, usually somewhat flattened, and with a slightly projecting mouth, as a vertical section (Fig. 10) shows. The wall is several cells thick, the membranes of the outer cells being rather thick and dark colored, while those of the inner cells are thin and delicate, with a tendency to become gelatinous. It is probable that the gelatinous substance of the spore cirrhus arises, in the present, as in other cases, by the breaking down of the innermost cells of the wall of the cavity. The spores are produced (Fig. 10) by budding from the interior cells of

the wall, and, when fully developed, fall from their attachments and become free in the central cavity. These spores correspond in all respects with the brown spores before mentioned as found in small numbers with the winter spores. The latter are undoubtedly developed in special spore cavities, corresponding in structure to those developed on gelatine, which occur sparingly among those producing winter spores (*ascospores*). But I have not yet been able to recognize them in sections of the knot. From the fact stated it becomes probable that this hitherto undescribed fruit form is the *pycnidial* fructification of the black-knot fungus, and it may be seen that it corresponds in general with the known *pycnidia* of related fungi.

The spores, which we may designate *pycnospores*, taken from pycnidia developed on gelatine, germinate in water as promptly and in the same way as those from the knot (Figs. 4 and 5). When sown on fresh nutrient gelatine, their threads develop much more rapidly and branch more freely than in water, as may be seen by a comparison of Figs. 5, *c*, and 5, *d*. On gelatine the spots formed by the masses of dark threads become evident to the unaided eye in eight or nine days, and new pycnidia and pycnospores are produced in from nine to ten days, a slightly longer time than that required for their development from the winter spores. I have not yet succeeded in obtaining perithecia with winter spores from cultures.

Dr. Farlow describes, in his paper, quoted above, four kinds of spore-fruits, as follows: (1) those producing winter spores (*ascospores*) in sacs; (2) those producing bodies which he terms *stylospores*, which form has since been named, by Saccardo,* *Hendersonula morbosa;* (3) spore-fruits of the type usually known as *spermogonia;* (4) others which he calls *pycnidia*, which differ essentially, however, from the pycnidia above described. Of these forms the third has not been met with in course of my studies, but it is yet too early to say it is not likely to be found. I have seen, in a few sections, small spore-fruits among the perithecia, which may be identical with Dr.

* See Sylloge Fungorum, Vol. III, p. 445.

Farlow's *pycnidia*, above mentioned. They have oblong or triangular cavities, lined with layers of small cells, from which are produced large numbers of nearly colorless, oval spores, about half as long as the pycnospores developed on gelatine. I have not been able to see that they are developed on short threads, as is said by Dr. Farlow to be the case with the spores in his pycnidia. Should this form be proved to belong to the life cycle of the knot-fungus, it will constitute its second pycnidial stage.

The *Hendersonula* or stylosporic form described by Dr. Farlow, which would constitute a pycnidial form, according to present terminology, has also not been found even to the extent of a single spore, though very careful and thorough search has been made for it. It is also to be expected that, if it were a genuine pycnidial stage of the fungus, it might be produced on cultures, as the pycnidia above described have been. This total failure to find the form has led me to give it up as a feature in the developmental history of *Plowrightia morbosa*. On consultation with Dr. Farlow, he has kindly permitted me to say here that he does not think there is sufficient evidence that this form is really a stage of the knot-fungus, although it frequently occurs with it.

The summer spores, when sown on prune gelatine, swell to an elliptical form, resembling that of the pycnospores, and germinate by producing threads (Fig. 7). These also form close, felted patches, and assume, after a time, the characteristic dark color before mentioned; and send up, finally, erect threads, which bear conidial spores like those from which they have grown (Fig. 8). No other form was developed on these cultures, even after a long time.

While considerable work remains to be done in deciding the connection of doubtful spore forms, and in completing the structural history of this pleomorphic fungus, the most important work now remaining is the investigation of its relations to its host plants. How it attacks them, how the knots begin to develop, and the history of their development, are the subjects which most need investigation now. This Department has not heretofore been prepared for this study, but the necessary preparations have been

made during the past season, and it is hoped that the work of the coming year may shed some light on these questions, which bear so directly and so practically on the treatment and prevention of the disease.

The Cucumber Mildew. — *Plasmopara Cubensis* (B. & C.).

In 1868, Berkeley and Curtis described* a fungus of the *Downy Mildew* group from specimens on a cucurbitaceous plant from Cuba, under the name *Peronospora Cubensis*. This fungus remained then comparatively unknown for twenty years; but meanwhile Spegazzini † had described a species on a cucurbitaceous host from the Argentine Republic, which he called *Peronospora australis*, and Trelease ‡ found the same species on the one-seeded star cucumber (*Sicyos angulatus*), in Wisconsin.

In 1889 Dr. W. G. Farlow § reported having received from Japan the previous year a fungus on cucumber leaves, and in 1889, from New Jersey, the same fungus on the leaves of hot-bed cucumbers. The same fungus appeared during 1889 on leaves of cucumbers and squashes in various parts of the country, and seemed likely to become a serious pest. The structure of the fungus is quite different from that of the only mildew heretofore known on *Cucurbitaceæ* in the United States, namely, *Peronospora australis* (compare Figs. 11 and 15); but a comparison with original specimens of the little-known *P. Cubensis* has shown it to be undoubtedly that species. Its almost simultaneous discovery in widely separated parts of the earth, where it had previously been wholly unknown, is a remarkable instance of the apparent vagaries of fungous epidemics, and shows how much we have yet to learn of the conditions which govern them.

This fungus attacked with fatal result a plot of cucumbers in Amherst the past season, and was received on

* Journal Linnæan Society, Botany, Vol. X, p. 363.
† Annales Sociedad Cientif. Argentina, 1881, XII, p. 81.
‡ Botanical Gazette, 1883, p. 331; see also Paras. Fungi Wisconsin, p. 6.
§ Botanical Gazette, 1889, p. 187.

squashes from Mr. S. F. Libby of Milford, Mass., who reported it as killing the leaves completely, and thus stopping the growth of the plant and its fruit. It is unquestionable that farmers and gardeners have here a new and serious hindrance to the successful cultivation of squashes and cucumbers; and there is no reason why it should not extend to melons also. The fungus has never been figured, so far as I am aware, and some facts in regard to its structure are yet lacking. It is, therefore, thought worth while to supply some of these deficiencies here, with figures, for comparison, of the mildew of the wild star cucumber, which may also, very possibly, be found on cultivated *Cucurbitaceæ* in the future.

The vegetative threads of *P. Cubensis* and of *P. australis* do not differ essentially from those of other downy mildews, and ramify among the cells of the host plant, sending into these cells at intervals absorbing organs or *haustoria*, by means of which they abstract nourishment from them, and weaken or ultimately kill them. Among the downy mildews we meet two types of these haustoria. In the grape-vine mildew and others, they are small, knob-like outgrowths from the fungus threads, merely large enough to reach the interiors of the cells of the host; while in others, like the mildews of the turnip and of spinach, mentioned later, they are large and branching, and often nearly fill the cells within which they are developed. In both of the species under discussion the haustoria are of the first type, as shown in Figs. 14 and 16. The haustoria of *P. australis* have been said to grow often large, sometimes filling the cell, but I have observed none such. From the vegetative threads grow out through the pores in the epidermis of the leaf, chiefly on its under surface, the threads which bear the summer spores or *conidia*. Those of *P. Cubensis* are quite scattered over the yellow and dead-looking spots caused by the development of the fungus in the leaf, and do not form a close felt visible to the naked eye, as do so many mildews, because it is rare that more than two of the conidial threads issue from a given leaf pore (Fig. 12). *P. australis*, on the contrary, forms dense white tufts of small extent on the

leaves of the star cucumber, because its conidial threads are developed in large numbers from each of a number of closely situated leaf pores. The structure of the spore-bearing threads in the two species is strikingly different, and furnishes the essential means of distinguishing between them. The details of this structure and the chief differences may best be understood from Figs. 11 and 15. Correlated with the development of small haustoria is frequently found, as in the grape-vine mildew and in *P. australis* (Fig. 15), a pinnate branching of the conidial threads, and conidia with an apical papilla, which germinate by producing *zoöspores* instead of a tube. In *P. Cubensis* we have the anomaly of conidial threads which follow the type of branching usually seen in the species with branched haustoria, and conidia of a violet tint, such as are almost unknown except among the latter group; while the haustoria are small, and the conidia have the apical papilla, and produce zoöspores on germination. This species goes far to break down the distinctions held by some writers to exist between the two groups which constitute the genera *Plasmopara* and *Peronospora* of recent writers, though all formerly included in *Peronospora*. If the distinction is to be maintained on the basis of the germination of the conidia, we must then call these two fungi *Plasmopara australis* (Speg.) and *Plasmopara Cubensis* (B. & C.). The formation of resting spores has not been observed in either species, yet it is evident that they have some means of surviving the winter. This is equally true of a considerable number of mildews; and the problem of what substitutes for resting spores certain species possess is one of the most interesting and important ones connected with these fungi.

This Department wishes to investigate all diseases affecting cucumbers, squashes and melons, cultivated either in the open air or under glass, and to this end urgently requests all persons who suffer from any disease of these crops to send specimens, with details as full as possible, to the writer, as soon as it appears.

The Brown Rot of Stone Fruits. — *Monilia fructigena* Pers.

The fact that great and sometimes almost total losses of the crop occur among the stone fruits, the peach, plum and cherry, through the attack of this disease, has been for some time recognized, more generally, perhaps, in this country than in Europe. Its effects have been described at some length by some European writers on plant diseases, while by others it is barely mentioned. So far as its general characters and cause are concerned, it has been pretty fully described by Peck,* Arthur,† Galloway‡ and Smith,§ and a brief summary will suffice here.

The disease is at first characterized by the browning of the fruit, whose flesh then becomes shrunken and shrivelled to a thin, tough pellicle over the stone, and remains in this condition and resists decay for an indefinite period. The term "mummied" aptly describes fruits which have been thus affected. Soon after it first turns brown, there may be seen thickly scattered over the surface of the fruit the ashy spore tufts of the fungus which has been shown to be the cause of the disease, and is known as *Monilia fructigena* Pers. The vegetative threads of this fungus ramify through the tissues of the fruit and break through the surface, where they produce spores in chains at their ends. When cultivated in the laboratory, these chains often reach a very great length, and branch more freely than is the case out of doors (Figs. 17–19). It may be easily observed on such specimens that the spores are formed by a sort of budding, the terminal one being the newest; and that where branching occurs it originates in a terminal cell, which assumes a somewhat triangular form, and buds from its two outer angles, as shown in Fig. 18. The spores, when fully formed, fall from the chains, and are capable of immediate germination. Under suitable conditions their germ threads can penetrate the uninjured skin of fruits, or

* Thirty-fourth Report N. Y. State Museum, p. 35 (1881).
† Fourth Report N. Y. Agric. Exp. Station, p. 254 (1885).
‡ Report U. S. Dep't. Agr., 1888, p. 349, and Plates V and VI.
§ Journal of Mycology. Vol. V, p. 123 (1889).

the tissues of flowers or even of leaves and young twigs, killing and browning all the tissues which they penetrate, and rapidly spreading. Finally, these threads come to the surface, and produce a new crop of spores.

Besides the stone fruits, this fungus is known to attack the apple, pear and others; but its destructive effects seem to be chiefly confined to the first named. My attention was called, in July, 1890, to a loss of early peaches, amounting to a very large percentage of the whole crop, in a small orchard of the Massachusetts Agricultural College, just following several days of warm and moist weather. The wholesale rotting then in progress was sufficient proof that the germ threads of the fungus can penetrate the uninjured skin of the peach, a power which has been doubted by some writers, though lately proved in laboratory cultures by Smith; for it is not to be supposed that most of the fruits on a tree were sufficiently injured to admit the entrance of germ threads otherwise unable to penetrate them. The mummied fruits usually remain hanging upon the branches, or lie, without decaying, on the ground beneath, until the following spring, when, as Smith has shown, the fungus threads, which have lain dormant through the winter, begin, under the influence of warmth and moisture, to grow again, and soon the apparently dead and harmless remains are covered with the ashy spore tufts, which will infect the new season's crop.

That the fungus does winter over in the dried flesh of its victims was further shown last April, by placing mummied plums, picked from the branches where they had hung all winter, before the weather was sufficiently warm to have caused any development, in a moist chamber in the laboratory. In two days the plums were thickly covered by the spore tufts of the fungus. A microscopic examination of the dried flesh from such plums just removed from the tree showed the presence of numerous threads, composed of large, thin-walled cells (Fig. 20, *a*), and of single thick-walled cells of somewhat varying form, which are probably to be regarded as the resting vegetative cells, known as *Chlamydosporcs* or *Gemmæ* (Fig. 20, *b*). It is probably these cells especially which are able to withstand

the unfavorable conditions of winter, and germinate again when circumstances favor once more. They have been shown to be able to retain their vitality for a long time, under certain circumstances, but it would seem that the dry air of a room is fatal in a comparatively short time; for plums of the previous season, picked April 1, and kept till November 1 in a dry pasteboard box, in a closet, failed entirely to produce the fungus in a moist chamber, though given abundant opportunity to do so. Galloway states that spores of the fungus collected in July, 1886, germinated in May, 1888, but does not state how they were kept meanwhile.

It has often been supposed that *Monilia* represents simply the summer spore form of some fungus whose other stages may be found on other substances. With a view to getting some light on this question, several cultures of the *Monilia* spores have been made on nutrient gelatine, prepared with an infusion of prunes; and one was continued for four and a half months, without, however, producing any other than *Monilia* spores, which appeared in three days after the beginning of the culture. These facts, and the abundant demonstration of the ability of its vegetative threads to survive the winter, apparently through the formation of resting cells or *Gemmæ*, point to the probability that, whatever its origin, any other forms once connected with it have been lost, and it is therefore fairly safe to regard it as an autonomous fungus. Other points of theoretical interest came up during the progress of the cultures, which will be discussed in a technical journal.

Assuming that the *Monilia*, which is classed among the imperfect fungi, is an independent form, and that the simple course of development sketched above constitutes the whole of its life cycle, the problem of avoiding to a large degree the losses now annually caused by it becomes a comparatively simple one. While something can probably be done by judicious spraying with fungicides, the question is largely one of orchard hygiene. If fruit growers could be made to realize the power for harm which lies in a few mummied fruits, they would readily understand that the prompt removal of every one which shows a

trace of this disease is the first necessity, and that the expense involved in a frequent inspection of the orchard during the fruiting season, and the thorough removal of all diseased twigs and fruits at the close of the season, would be manyfold repaid in the increased returns. The caution cannot be too often repeated, that all plants or parts of plants attacked by fungi should be burned at once, in order to completely destroy all spores contained in or upon them, and so prevent their becoming a source of infection. Of course, where several orchards lie in the same neighborhood, the owners of all must co-operate, to secure the best results; but if this were done, and all orchards put into a thoroughly healthy condition every fall, the losses from this and some other diseases would hardly be worthy of mention. The pathologist can do no more; and, if the cultivator will persist in the old uncleanly and wasteful way, let him take the consequences, and blame no one else.

Potato Scab.

Field experiments in continuation of those of 1889, and on lines suggested by the experience of that year, were carried out during the past season under fairly favorable conditions; and the results, though almost wholly negative, are not without practical value.

After the harvesting of the crop in 1889, the plot devoted to potato experiments was ploughed, and its southern half, including sections 1 to 14, was sown with winter rye, in order that it might have, as far as possible, the character of sod land when ploughed in the spring. The rye came up and made good growth before the close of the season. In the spring it was in vigorous growth, and eight inches high when the plot was again ploughed, May 7. The whole plot was dressed with bone and potash, in the same amounts as in the previous years, and this dressing and the green rye were harrowed in.

Seven varieties of potatoes had been obtained in quantity from Mr. G. D. Howe of North Hadley, together with small sample lots of six other varieties. The chief varieties were the Monroe County Prize, Quinnipiac, Triumph,

White Seedling, Houlton Rose, Hampden Beauty, and Rural New Yorker, No. 2; while those of which small samples were received were Howe's Premium, Rough Diamond, Northern Spy, Early Market, Golden Flesh and Dakota Red. Retaining the same division into sections as was used last year, each of the principal varieties was planted in drills on four sections, except the Monroe County Prize, which was planted on only three sections, thus leaving one section, No. 14, for the samples, of each of which half a row was planted. The chief varieties were so arranged that two sections of each were on that half of the plot which had been sown to rye, and two on the other half; and so that one row of each was planted somewhat deeper and one considerably deeper than the usual depth of planting. All the varieties grew well and received the proper cultivation. In spite of the considerable interval between the maturity of the Triumph, the earliest, and that of the Rural New Yorker, the latest, all were allowed to remain in the ground until the last was matured, and were dug on the 16th and 17th of September. The crop was much better than that of 1889, and markedly less scabby. The results need not be given in full detail, since this would involve unnecessary repetition. It is sufficient to say that they fully warrant, so far as they go, the following statement, which must, however, be given no more weight than that due to a single experiment.

1. The only variety which showed no scab was the Rough Diamond, which, however, has few other features to recommend it, and seems interesting chiefly as a curiosity.

2. The best varieties, both in the general character of the crop and in their comparative freedom from scab, were the Rural New Yorker and White Seedling.

3. The ploughing-in of winter rye produced no perceptible effect on the scabbiness of potatoes raised on that half of the plot, as compared with the other half.

4. The comparison of results from deep and shallow drills does not bear out the opinion, doubtfully expressed last year, that deep planting diminishes scab. Neither for any single variety nor for the plot as a whole was any

distinct advantage in this respect noticeable for either method of planting.

5. The free use of coal ashes in the drill, which was tried by request, had no observable influence on the development of scab in the present case, although it has been thought by some to favor its development, and others have regarded it as a preventive.

6. The thicker-skinned and red-skinned varieties show no greater resistance to scab than others; our best results this season were from light-skinned and rather delicate, fine-grained sorts. These results conflict with some rather general beliefs, but they are the outcome of experiments carefully planned and carried out, and involve no inherent improbabilities.

The results of extended studies as to the *cause* of potato scab have lately been published by Mr. H. L. Bolley.* He believes it to be due to the action of a *Bacterium* which lives in the soil, and can live parasitically on the potato tuber, causing an irritation which results in the formation of the scab. Mr. Bolley's experiments were well planned and apparently carefully conducted, and his results are of much value. The scab produced by him was apparently the form first called by the writer in the last report of this station the "surface" form. In Bulletin No. 105 of the Connecticut Agricultural Experiment Station, Dr. Roland Thaxter has announced the results of some investigations, in which he had obtained, from potatoes affected by the "deep" form of scab, a vegetable organism of doubtful relationships, which, when sown on growing potatoes, reproduced the same form of the disease in a striking manner.

In our own microscopic study of scabbed potatoes, bacteria were, of course, constantly met with, and fungus threads occasionally, but never under such circumstances as to raise any serious suspicion of their causal relation to the trouble. Had such a suspicion been raised, however, it would have been impossible to have demonstrated the correctness or falsity of the view, since the Department had then

* Agric. Science, September and October, 1890.

neither the necessary accommodations nor equipment for such investigations. At present other equally important studies are in progress, and it does not seem advisable for us to take up the subject, especially since the bacteriological investigations are of a very special nature, and are best conducted by persons who devote their entire attention to that field. It is to be hoped, however, that some European bacteriologist will take up the subject, and repeat the investigations already made in this country; since, as was shown in our last report, the same disease prevails there, at least in its "surface" form, as well as here.

From what has been already said, it is evident that the term "scab," as commonly used, is a general and not a specific one. The rough crusts which give rise to the name are cork formations produced by the growing tuber, in response to, and as an attempted protection against, external irritating influences. That this irritation is sometimes due to parasitic or semi-parasitic organisms seems probable, in the light of the investigations mentioned above; but that it is always so produced is by no means proved, since, in practice, badly diseased tubers have too often given a practically smooth crop. One who insists on the presence of some specific organism as a necessary preliminary to the development of scab must admit a very strong dependence on peculiar conditions on the part of such organism.

It is difficult to believe that the "deep" form of the scab is entirely distinct from the "surface" form, as Dr. Thaxter's results would indicate, although he has found potatoes attacked only by the former near New Haven, Conn., the past season; for both forms have occurred abundantly on potatoes from the same hill on our experimental plots, and not uncommonly both on the same tuber. And the "deep" form has shown, in our experience, such differences in depth as almost to furnish a series running up to the "surface" form; yet it is true that a certain darker and more decayed appearance almost always distinguishes it from the latter.

With regard to the prevention of these troubles, whatever their cause, our recommendation of last year can be repeated with much stronger emphasis. The best land for

potatoes, so far as freedom from scab is concerned, is a light, porous, sandy soil. On such land there may often be raised, year after year, perfectly smooth crops; while on damp, heavy soil, as bad a crop may result the first year as after years of continuous potato culture. At present, then, we can only say that what is termed potato-scab is due to the reaction of one or more of several possible external irritants upon the tubers while they are growing, and that the conditions which least favor its appearance are those afforded by a *light, open, thoroughly drained soil.*

Notes.

Damping off. — During the past fall, a few cucumber seedlings in the Station greenhouse were killed by the affection known as "damping off," so common and destructive to seedlings in the forcing bench and the hot-bed. The disease, which manifests itself in the decay and consequent falling over of the seedling stem near the level of the surface of the soil, is familiar to most persons who raise plants under glass.

So far as I am aware, the cause of this trouble has not been precisely investigated in this country, though it has been assumed to be caused by the fungus which is known to produce the same effect in Europe, *Pythium de Baryanum* Hesse. The case mentioned afforded an opportunity to ascertain the correctness of this assumption. Examination of the stem of a fallen seedling at the point of attack showed the presence of abundant fungus threads in its disorganized tissues. A piece was placed in a drop of water in a moist chamber, and the threads rapidly extended themselves over the glass slip which held the whole, and in two days had developed the reproductive organs figured in Figs. 21 to 23. These structures agree with those of *P. de Baryanum*, as figured by Hesse, and the fungus is probably the same as that which produces the same results in Europe.

This fungus is closely related to the downy mildews, and reproduces itself by means of zoöspores and by resting spores. Fig. 21 shows two zoösporangia, and in Fig. 23 are seen

some stages in the production of resting spores. Other resting bodies (*gemmæ*) may be formed from the threads in a purely vegetative way (Fig. 22).

The very general distribution of this fungus is indicated by the fact that the soil in which the affected seedlings grew in the present case was, as nearly as possible, virgin soil, having just been brought from a natural woodland, where it had probably been undisturbed for a very long period, into a new greenhouse then first used.

Assuming that "damping off" is always caused by the same fungus, certain directions for its treatment may be given. Plants affected should be at once removed, with the soil immediately surrounding them, and burned. If this is done *as soon as* the seedling falls, the trouble can be held in check, since the fungus will be destroyed before its reproductive organs have developed. When a hot-bed or propagating bench has become so badly infested by the fungus that a large part of the seedlings or cuttings "damp off," the soil should be entirely removed to a distance, and the containing walls thoroughly cleaned and washed with strong whitewash, and refilled with fresh earth. After this treatment, the prompt removal of diseased plants should be sufficient to limit the trouble to an occasional case.

The Mildew of Spinach (*Peronospora effusa* (Grev.) Rabh.) caused serious damage to that crop on the grounds of the Massachusetts Agricultural College. This fungus is one of the downy mildews, and makes its presence known by the appearance of discolored blotches on the upper surface of the leaf, and corresponding patches of its closely matted spore-bearing threads on the lower surface. Since this crop is cultivated for the leaves, the disease should be controlled by picking and destroying the leaves as fast as they become attacked, and by thorough cleaning of the field as soon as the crop is removed.

Spinach belongs to the same family of plants with some of our common weeds, which are also attacked by this mildew. One of these which appears in almost every field is the so-called pigweed or lamb's quarters (*Chenopodium album*). This plant is equally subject to the attack of the

same fungus; and this fact makes it obvious that spinach fields should be kept scrupulously free from pigweed, which, if allowed to grow, may afford a favorable breeding place for the mildew.

The Grape-vine Mildew (*Plasmopara viticola* (B. & C.) Berl. & de T.) might be expected to attack also our native species of *Ampelopsis*, the Virginia Creeper, and the species from Japan, now commonly planted under the name of Japanese or Boston ivy, since the species of *Ampelopsis* are so nearly related to the grapes that they are placed by some writers as a subdivision of the genus *Vitis*, which includes the true grapes. Its occurrence on the Virginia Creeper has been reported from various localities; but, so far as I know, the Japanese ivy (*A. Veitchii*) has been only once reported as its host.* It is therefore worth while to note the occurrence of the mildew on the latter plant, in October last, in Amherst. The fungus was well developed, almost as luxuriant as on the grape, and its summer spores, always varying considerably in size, showed an unusually wide range of dimension. The leaves attacked were large and strong, and the fungus threads penetrated their tissues very thoroughly, though a careful examination failed to discover the resting spores. The damage to the vines, which were well established and vigorous, was not important, and the chief interest of the facts noted lies in the possible danger to grape vines in the proximity of wild or cultivated *Ampelopsis* plants, which may serve as an important source of infection, if their presence is overlooked. The simplest precaution is, naturally, that of rigorously excluding the species named from the neighborhood of grape vines.

Two closely related fungi appeared to a considerable extent on a plot of purple-topped white turnips on the Station grounds in September last. They were the Downy Mildew (*Peronospora parasitica* (P.) Tul.) and the White Rust (*Cystopus candidus* (Pers.) Lev.) of *cruciferous* plants. They often appear together, and sometimes do considerable damage. Any field on which they

* Journal of Mycology, 1889, p. 202.

have appeared, and on which it is intended to plant turnips, cabbages, radishes, or any cruciferous crop, the next year, should be carefully cleaned of all refuse, leaves, etc., as soon as the crop is harvested; since these fungi winter over by means of resting spores developed in the leaves and stems, and set free by their decay.

Late potatoes have been an almost total loss throughout the State, on account of the attacks of the POTATO-ROT fungus (*Phytophthora infestans* (Mont.) de By.). As the weather early in the season was not especially favorable to the development of the fungus, early potatoes were, as a rule, harvested in excellent condition; but a period of warm, moist weather in September was fatal to the late crop. A few complaints of rotting were received early in the season, but whenever specimens were sent they showed no fungus, but merely a browning and shrivelling, due probably to the rather severe drought prevailing at the time. In accordance with a request, the following brief account of the characteristic appearance of leaves attacked by the rot fungus is here given. The spots, at first yellow, soon become of a dark-brown or blackish, muddy color, quite different from the clearer and lighter brown of merely dried leaves. Another peculiarity of these spots is their soft, rotten condition, very different from that produced by drying up, or by most other fungi. Around the edges of the dark spots may usually be observed, on close examination, especially with a hand magnifier, and chiefly on the lower side of the leaf, a delicate white "fuzz," composed of the spore-bearing threads of the fungus. The disease usually appears first at some part of a field, and thence spreads, frequently in a definite direction, with the prevailing wind.

Only the promptest action can save a field where the fungus has begun to spread; but it has been repeatedly shown that the sufficiently prompt and frequent application to the plants of the Bordeaux mixture, the materials for which must be kept on hand, will avert a very large part of the threatened loss.

THE ELDER RUST (*Æcidium Sambuci* Schw.) has been very abundant during the past season on our common elder

(*Sambucus Canadensis*), and its cultivated variety *aurea*, and was sent from Brookline by W. H. Manning, Esq., who reported it as greatly disfiguring the ornamental cut-leaved black elder (*S. nigra*, var. *laciniata*). It occurs on the leaf blades and stalks, where it causes the normal tissue to become greatly overdeveloped, producing large, fleshy masses, which distort the leaf and bear the spore cups on their surfaces.

The fungus is one which is difficult to deal with, as so little is known of its life history. It is the *cluster-cup* stage of one of the rust fungi, and none of the other stages has been found on the elder. It is probable that these occur on some other host plant; but, until the connection is established, little can be done to prevent its attacks, except to remove the affected foliage and burn it. The fact of the prevalence of the fungus in one season, however, does not prevent its being very rare in the next; and the controlling conditions are, as yet, very little understood.

The Rust of Blackberries and Raspberries (*Cæoma nitens* Schw.) is one of the commonest and most striking of our fungi. It produces at first a stunted and yellowish appearance of the shoots attacked, which is soon followed by the development of the spores in brilliant orange patches, almost or quite covering the lower surfaces of the leaves.

Experiments point to the probability that its spread by means of its spores can be checked by spraying with the Bordeaux mixture; but when a plant is once attacked there is no alternative but to dig it up and burn it, since the vegetative threads of the fungus live through the winter in the stalks, and thence penetrate the new shoots and leaves in the spring, developing the spores on the leaves. The spores are summer spores and have not yet been proved to be connected with any resting-spore form, but it is not improbable that such a connection may yet be traced; though its ability to hibernate in the host plant makes it possible that we have to deal with an independent form.

The Hollyhock Rust (*Puccinia Malvacearum* Mont.) has become, within a few years, an important disease in Massachusetts. It is a native of Chili, whence it was intro-

duced into Europe some years ago. In 1885 it was brought to this country with some imported *Malope* planted at Beverly Farms, Mass., and spread to the hollyhocks there in 1886. From this point, or possibly from other points as well, it extended, appearing in Boston, Cambridge, Nahant and elsewhere, and has been recently observed in central New York. It was forwarded this year to the station by G. L. Lovett, Esq., of West Newton.

The spores have the structure of the resting spores of the rusts, but are not resting spores, since they germinate at once, and infect new plants. Perhaps the last spores of the season are resting spores, by which the fungus survives the winter, as has been shown to be the case with some similar species. Affected plants should be promptly removed and destroyed, if it is desired to protect those still unharmed.

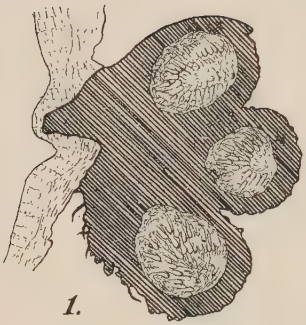
Disease of Oats. — The Massachusetts Crop Report for June, 1890, contained numerous complaints, especially from the western counties, of the failure of oats from "rusting;" and the October Report mentions oats among the crops which generally failed throughout the State. Letters to the Crop Report correspondents in Barre, Deerfield and Ludlow brought replies and specimens of the affected oats, for which the gentlemen named have the thanks of this Department. In every case the plants had a general brown or "rusty" color, but their appearance was quite different from that of plants attacked by the grain-rust fungi (*Puccinia graminis* Pers., *P. coronata* Cda., etc.). No fungus or animal could be detected in any part of the plant, but Bacteria were always present. Other work prevented any detailed study of the trouble; but there is no reason to doubt that it is the same which was very generally reported from the Eastern and Central States, and which materially reduced the oat crops of those sections. This disease has been investigated by the Division of Vegetable Pathology of the United States Department of Agriculture, and is regarded as caused by a specific Bacterium.* Until our knowledge of it is much more com-

* Journal of Mycology, 1890. p. 72.

plete, no recommendations concerning treatment can be made; and, indeed, it is by no means improbable that it may prove to be so dependent upon meteorological and other conditions as not to occur again for a long period, as has been suggested.

Note on Fungicides.

Formulæ for some of the most useful fungicides were given in our last report, at page 212. The materials for the preparation of these and others, together with an effective spraying pump, were purchased by the station last spring, in the expectation that we should be able to test them on crops on the station plots during the season. No fungous disease appeared on any crop, however, to such a degree as to render any test of fungicides possible, and the outfit and materials remain in our hands for use next season, should circumstances favor. Full directions for preparing and applying such fungicides as the latest experience has shown to be most valuable will be given in a bulletin of this station early next spring.



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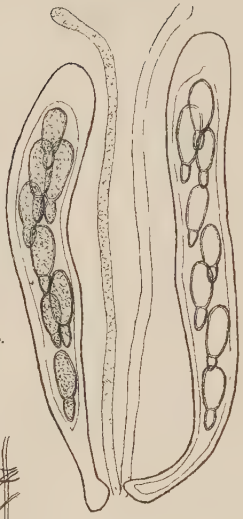

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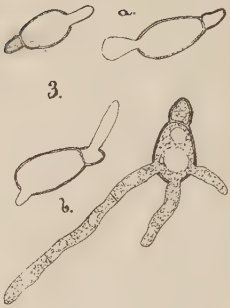

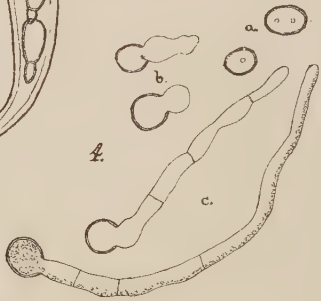

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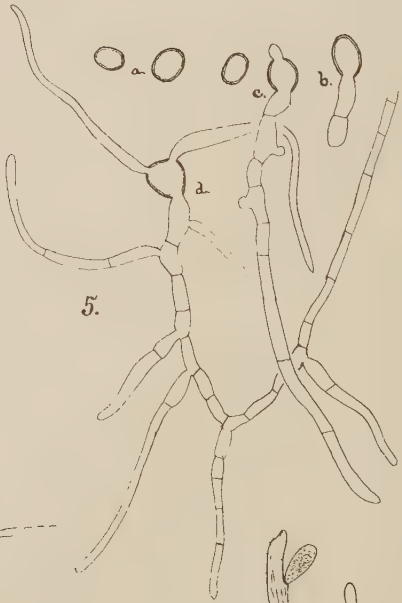

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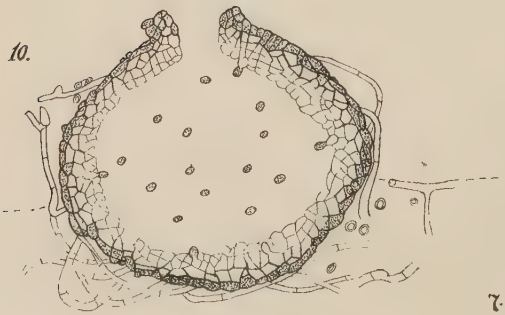

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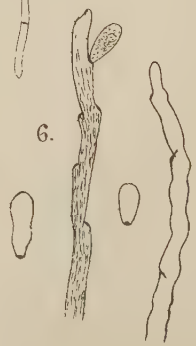

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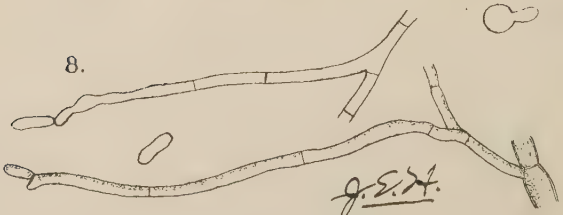


EXPLANATION OF PLATE I.

The Fungus of Black Knot. (*Plowrightia Morbosa* (Sz.) Sacc.)

Fig. 1. Diagrammatic representation of a section through three perithecia containing spore sacs (*asci*). x 72.*

Fig. 2. Two sacs containing ripe spores, and two sterile threads (*paraphyses*). x 940.

Fig. 3. Four winter spores (*ascospores*), germinating in water; *a*, after one day; *b*, after two days. x 940.

Fig. 4. Six *pycnospores* from a knot; *a*, just placed in water; *b*, after one day; *c*, after two days in water. x 940.

Fig. 5. Six *pycnospores* from a *pycnidium* developed on gelatine from winter spores; *a*, three fresh spores; *b*, a spore after one day in water; *c*, a spore after two days in water; *d*, a spore after two days on nutrient gelatine. *d* x 540; others x 940.

Fig. 6. Three summer spores (*conidia*), with two of the threads on which they are borne. x 940.

Fig. 7. Three summer spores beginning to germinate after one day on nutrient gelatine. x 940.

Fig. 8. Threads bearing new crop of summer spores produced on gelatine culture of summer spores from young knot, shown in Figs. 6 and 7. x 540.

Fig. 9. Surface view, from above, of a *pycnidium* developed on gelatine from winter spores. x 350.

Fig. 10. Vertical section through such a *pycnidium*, showing origin of spores. x 350.

Drawn chiefly from a single section, but completed in some details from others. The threads about the mouth are not shown in the section.

* The number given after each figure represents the degree of magnification of the original drawing, which has been reduced about one-third in this plate. The magnification of the figures, as here given, is therefore about two-thirds of that indicated by the printed numbers.

EXPLANATION OF PLATE II.

The Cucumber Mildew. (*Plasmopara Cubensis*) (B. & C.)

Fig. 11. A conidial thread arising from a vegetative thread; *sp.*, two summer spores (*conidia*). x 540.*

Fig. 12. A portion of a vegetative thread giving rise to two conidial threads through the same leaf-pore. x 540.

Fig. 13. A young conidial thread with the spores not yet fully developed and still in place. x 540.

Fig. 14. A portion of a vegetative thread among the cells of a leaf, four of which are shown, and penetrating them by its *haustoria*, *h*. x 540.

The Mildew of the Star Cucumber. (*Plasmopara australis* Spag.)

Fig. 15. A conidial thread and spores; *a* x 350 ; *sp.* spores x 540.

Fig. 16. A portion of a vegetative thread, with *haustoria*, *h*. x 540.

The Brown Rot of Stone Fruits. (*Monilia fructigena* Pers.)

Fig. 17. Spore chains. x 540.

Fig. 18. End of a growing chain, showing beginnings of new spores and origin of branching. x 540.

Fig. 19. Threads terminating in spore chains, developed in five days from spores sown on nutrient gelatine. x 200.

Fig. 20. Threads, *a*, and resting cells (*Gemmæ*), *b*, from the flesh of "mummied" plums, in winter. x 540.

The "Damping-off" Fungus. (*Pythium de Baryanum* Hesse.)

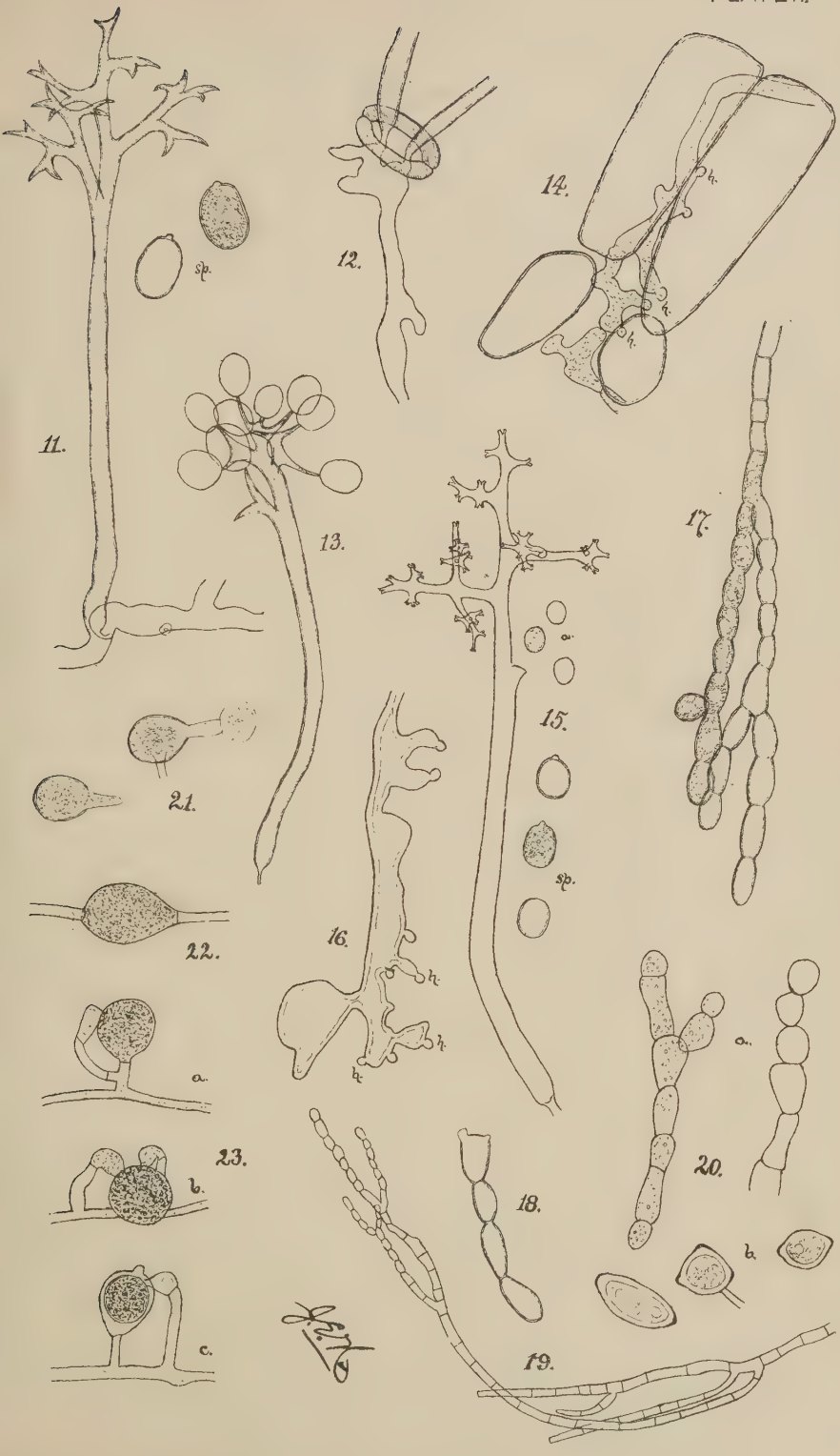
Fig. 21. Two *zoösporangia*, showing beginnings in formation of *zoöspores*. x 540.

Fig. 22. A resting cell (*Gemma*). x 540.

Fig. 23. Sexual organs; *a*, female cell (*oögonium*), with a single male (*antheridium*) ; *b*, with two males ; *c*, resting spore (*oöspore*), formed and fertilized as shown by emptying of male cell. x 540.

* See note to Plate I.

PLATE II.



SPECIAL WORK IN THE CHEMICAL LABORATORY.

I. Communication on commercial fertilizers : —
   1. General introduction.
   2. Laws for the regulation of the trade in commercial fertilizers.
   3. List of licensed manufacturers for May 1, 1889, to May 1, 1890.
   4. Analyses of licensed fertilizers.
   5. Analyses of commercial fertilizers and manurial substances sent on for examination.
   6. Miscellaneous analyses.

II. Water analyses.

III. Compilation of analyses made at Amherst, Mass., of agricultural chemicals and refuse materials used for fertilizing purposes.

IV. Compilation of analyses made at Amherst, Mass., of fodder articles, fruits, sugar-producing plants, dairy products, etc.

I. Communication on Commercial Fertilizers.

1. General introduction.
2. Laws for the regulation of the trade in commercial fertilizers.
3. List of licensed manufacturers for May 1, 1889, to May 1, 1890.
4. Analyses of licensed fertilizers.
5. Analyses of commercial fertilizers and manurial substances sent on for examination.
6. Miscellaneous analyses.

1. General Introduction.

The trade in commercial fertilizers has been quite active in our State during the past year. Fifty-one manufacturers and dealers in manurial substances have applied for and received certificates for their compliance with our State laws for the regulation of the trade in commercial fertilizers; twenty-nine of these are residing in the State, while twenty-two are residents of other States.

One hundred and fifty-eight samples of licensed articles of various description have been collected in all parts of the State by a duly authorized agent of the station. They were analyzed at the chemical laboratory of the latter, with the following results: fifty-four samples contained one single essential constituent below the lowest guaranty; ten samples contained two essential constituents below the lowest guaranty; three samples contained all three essential constituents below the lowest guaranty; fifty-six samples contained one essential constituent above the highest guaranty; thirteen samples contained two essential constituents above the highest guaranty; four samples contained all three essential constituents above the highest guaranty. The deficiency in regard to one or two essential constituents was in the majority of cases commercially compensated by the excess of another one.

The fluctuation in the market price of most standard articles used in the manufacture of compound fertilizers has been within the usual limits during the past season. Tankage, nitrate of soda, blood, azotin and sulphate of

potash declined during the middle of May. Bones, refuse bone-black and crude phosphate rock have remained unchanged in price since January 1. Muriate of potash and kainite held their own, while sulphate of ammonia advanced somewhat. Judging from present indications, some changes regarding the cost of commercial fertilizers may be expected for the coming season.

The duties assigned to the director of the station, to act as inspector of commercial fertilizers, render it necessary to discriminate, in official publications of the results of analyses of commercial fertilizers and of manurial substances in general made at the station, between analyses of samples collected by a duly qualified delegate of the experiment station, in conformity with the rules prescribed by the new laws, and those analyses which are made of samples sent on for that purpose by outside parties. In regard to the former alone can the director assume the responsibility of a carefully prepared sample, and of the identity of the article in question.

The official report of analyses of compound fertilizers and of all such materials as are to be used for manurial purposes, which are sold in this State under a certificate of compliance with the present laws for the regulation of the trade in these articles, has been restricted by our State laws to a statement of chemical composition, and to such additional information as relates to the latter. The practice of affixing to each analysis of this class of fertilizers an approximate commercial valuation per ton of their principal constituents has, therefore, been discontinued. This change, it is expected, will tend to direct the attention of the consumers of fertilizers more forcibly towards a consideration of the particular composition of the different brands of fertilizers offered for their patronage, — a circumstance not unfrequently overlooked.

The approximate market value of the different brands of fertilizers, obtained by the current mode of valuation, does not express their respective agricultural value, *i.e.*, their crop-producing value; for the higher or lower market price of different brands of fertilizers does not necessarily stand in a direct relation to their particular fitness, without

any reference to the particular condition of the soil to be treated, and the special wants of the crops to be raised by their assistance. To select judiciously, from among the various brands of fertilizers offered for patronage, requires, in the main, two kinds of information; namely, we ought to feel confident that the particular brand of fertilizer in question actually contains the guaranteed quantities and qualities of essential articles of plant food at a reasonable cost, and that it contains them in such form and such proportions as will best meet existing circumstances and special wants. In some cases it may be mainly either phosphoric acid or nitrogen or potash; in others, two of them; and in others again, all three.

A remunerative use of commercial fertilizers can only be secured by attending carefully to the above-stated considerations.

To assist farmers not yet familiar with the current mode of determining the commercial value of manurial substances offered for sale in our markets, some of the essential considerations, which serve as a basis for their commercial valuation, are once more stated within a few subsequent pages.

The hitherto customary valuation of manurial substances is based on the average trade value of the essential fertilizing elements specified by analysis. The money value of the higher grades of agricultural chemicals, and of the higher-priced compound fertilizers, depends in the majority of cases on the amount and the particular form of two or three essential articles of plant food — *i.e.*, phosphoric acid, nitrogen and potash — which they contain. To ascertain, by this mode of valuation, the approximate market value of a fertilizer (*i.e.*, the money worth of its essential fertilizing ingredients), we multiply the pounds per ton of nitrogen, etc., by the trade value per pound; the same course is adopted with reference to the various forms of phosphoric acid and of potassium oxide. We thus get the values per ton of the several ingredients, and, adding them together, we obtain the total valuation per ton in case of cash payments at points of general distribution.

The market value of low-priced materials used for manurial purposes, as salt, wood ashes, various kinds of lime, barn-yard manure, factory refuse and waste materials of different description, quite frequently does not stand in a close relation to the market value of the amount of essential articles of plant food they contain. Their cost varies in different localities. Local facilities for cheap transportation, and more or less advantageous mechanical condition for a speedy action, exert, as a rule, a decided influence on their selling price.

The mechanical condition of any fertilizing material, simple or compound, deserves the most serious consideration of farmers, when articles of a similar chemical character are offered for their choice. The degree of pulverization controls, almost without exception, under similar conditions, the rate of solubility, and the more or less rapid diffusion of the different articles of plant food throughout the soil.

The state of moisture exerts a no less important influence on the pecuniary value in case of one and the same kind of substance. Two samples of fish fertilizers, although equally pure, may differ from fifty to one hundred per cent. in commercial value, on account of mere difference in moisture.

Crude stock for the manufacture of fertilizers, and refuse materials of various descriptions, have to be valued with reference to the market price of their principal constituents, taking into consideration at the same time their general fitness for speedy action.

Trade Values of Fertilizing Ingredients in Raw Materials and Chemicals.

	1890. Cents per Pound.
Nitrogen in ammoniates,	17
Nitrogen in nitrates,	14½
Organic nitrogen in dry and fine ground fish, meat, blood,	17
Organic nitrogen in cotton-seed meal and castor pomace,	15
Organic nitrogen in fine ground bone and tankage,	16½
Organic nitrogen in fine-ground medium bone and tankage,	13
Organic nitrogen in medium bone and tankage,	10½

Trade Values of Fertilizing Ingredients in Raw Materials and Chemicals — Concluded.

	1890. Cents per Pound.
Organic nitrogen in coarser bone and tankage,	8½
Organic nitrogen in hair, horn-shavings and coarse fish scraps,	8
Phosphoric acid soluble in water,	8
Phosphoric acid soluble in ammonium citrate,	7½
Phosphoric acid in dry ground fish, fine bone and tankage,	7
Phosphoric acid in fine medium bone and tankage,	6
Phosphoric acid in medium bone and tankage,	5
Phosphoric acid in coarse bone and tankage,	4
Phosphoric acid in fine-ground rock phosphate,	2
Potash as high-grade sulphate, and in forms free from muriate or chlorides, ashes, etc..	6
Potash as kainite,	4½
Potash as muriate,	4½

The organic nitrogen in superphosphates, special manures and mixed fertilizers of a high grade, is usually valued at the highest figures laid down in the trade values of fertilizing ingredients in raw materials, namely, seventeen cents per pound; it being assumed that the organic nitrogen is derived from the best sources, viz., animal matter, as meat, blood, bones, or other equally good forms, and not from leather shoddy, hair, or any low-priced, inferior form of vegetable matter, unless the contrary is ascertained. For similar reason, the insoluble phosphoric acid is valued in this connection at three cents, it being assumed, unless found otherwise, that it is from bone or similar sources, and not from rock phosphate. In this latter form the phosphoric acid is worth but two cents per pound.

The above trade values are figures at which, in the six months preceding March, 1890, the respective ingredients could be bought at retail for cash in our large markets, in the raw materials, which are the regular source of supply.

They also correspond to the average wholesale prices for the six months ending March 1, plus about twenty per cent. in case of goods for which we have wholesale quotations. The valuations obtained by use of the above figures will be found to agree fairly with the retail price at the large markets of standard raw materials, such as: —

Sulphate of ammonia,	Dry ground fish,
Nitrate of soda,	Azotin,
Muriate of potash,	Ammonite,
Sulphate of potash,	Castor pomace,
Dried blood,	Bone and tankage,
Dried ground meat,	Plain superphosphates.

A large percentage of commercial materials consists of refuse matter from various industries. The composition of these substances depends upon the mode of manufacture carried on. The rapid progress in our manufacturing industries is liable to affect, at any time, more or less seriously, the composition of the refuse. To assist the farming community in a clear and intelligent appreciation of the various substances sold for manurial purposes, a frequent examination into the temporary characters of agricultural chemicals and refuse materials offered in our markets for manurial purposes is constantly carried on at the laboratory of the station.

Consumers of commercial manurial substances do well to buy, whenever practicable, on guarantee of composition with reference to their essential constituents; and to see to it that the bill of sale recognizes that point of the bargain. A mistake or misunderstanding may be readily adjusted, in that case, between the contending parties. The responsibility of the dealer ends with furnishing an article corresponding, in its composition, with the lowest stated quantity of each specified essential constituent. Our present laws for the regulation of the trade in commercial fertilizers include not only the various brands of compound fertilizers, but also all materials, single or compound, without reference to source, used for manurial purposes, when offered for sale on our market at ten dollars or more per ton.

Copies of our present laws for the regulation of the trade in commercial fertilizers may be had by all interested, on application at the Massachusetts State Agricultural Experiment Station, Amherst, Mass.

2. *Laws for the Regulation of the Trade in Commercial Fertilizers.*

[Chap. 296.]

An Act to regulate the sale of commercial fertilizers

Be it enacted, etc., as follows:

Section 1. Every lot or parcel of commercial fertilizer or material used for manurial purposes sold, offered or exposed for sale within this Commonwealth, the retail price of which is ten dollars or more per ton, shall be accompanied by a plainly printed statement clearly and truly certifying the number of net pounds of fertilizer in the package, the name, brand, or trade-mark under which the fertilizer is sold, the name and address of the manufacturer or importer, the place of manufacture, and a chemical analysis stating the percentage of nitrogen or its equivalent in ammonia, of potash soluble in distilled water, and of phosphoric acid in available form soluble in distilled water and reverted, as well as the total phosphoric acid. In the case of those fertilizers which consist of other and cheaper materials, said label shall give a correct general statement of the composition and ingredients of the fertilizer it accompanies.

Sect. 2. Before any commercial fertilizer, the retail price of which is ten dollars or more per ton, is sold, offered or exposed for sale, the importer, manufacturer or party who causes it to be sold or offered for sale within the state of Massachusetts, shall file with the director of the Massachusetts agricultural experiment station, a certified copy of the statement named in section one of this act, and shall also deposit with said director at his request a sealed glass jar or bottle, containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample thereof.

Sect. 3. The manufacturer, importer, agent or seller of any brand of commercial fertilizer or material used for manurial purposes, the retail price of which is ten dollars or more per ton, shall pay for each brand, on or before the first day of May annually, to the director of the Massachusetts agricultural experiment station, an analysis fee of five dollars for each of the three following fertilizing inredients: namely, nitrogen, phosphorus, and potassium, contained or claimed to exist in said brand or fertilizer: *provided*, that whenever the manufacturer or importer shall have paid the fee herein required for any person acting as agent or seller for such manufacturer or importer, such agent or seller shall not be required to pay the fee named in this section; and on receipt of said analysis fees and statement specified in section two, the

director of said station shall issue certificates of compliance with this act.

Sect. 4. No person shall sell, offer or expose for sale in the state of Massachusetts, any pulverized leather, raw, steamed, roasted, or in any form as a fertilizer, or as an ingredient of any fertilizer or manure, without an explicit printed certificate of the fact, said certificate to be conspicuously affixed to every package of such fertilizer or manure and to accompany or go with every parcel or lot of the same.

Sect. 5. Any person selling, offering or exposing for sale, any commercial fertilizer without the statement required by the first section of this act, or with a label stating that said fertilizer contains a larger percentage of any one or more of the constituents mentioned in said section than is contained therein, or respecting the sale of which all the provisions of the foregoing section have not been fully complied with, shall forfeit fifty dollars for the first offence, and one hundred dollars for each subsequent offence.

Sect. 6. This act shall not affect parties manufacturing, importing or purchasing fertilizers for their own use, and not to sell in this state.

Sect. 7. The director of the Massachusetts agricultural experiment station shall pay the analysis fees, as soon as received by him, into the treasury of the station, and shall cause one analysis or more of each fertilizer or material used for manurial purposes to be made annually, and publish the results monthly, with such additional information as circumstances advise: *provided*, such information relate only to the composition of the fertilizer or fertilizing material inspected. Said director is hereby authorized in person or by deputy to take a sample, not exceeding two pounds in weight, for analysis, from any lot or package of fertilizer or any material used for manurial purposes which may be in the possession of any manufacturer, importer, agent or dealer; but said sample shall be drawn in the presence of said party or parties in interest or their representative, and taken from a parcel or a number of packages which shall be not less than ten per cent. of the whole lot inspected, and shall be thoroughly mixed and then divided into two equal samples and placed in glass vessels and carefully sealed and a label placed on each, stating the name or brand of the fertilizer or material sampled, the name of the party from whose stock the sample was drawn and the time and place of drawing, and said label shall also be signed by the director or his deputy and by the party or parties in interest or their representatives present at the drawing and sealing of said sample; one of said duplicate samples shall be retained by the director and the

other by the party whose stock was sampled. All parties violating this act shall be prosecuted by the director of said station; but it shall be the duty of said director, upon ascertaining any violation of this act, to forthwith notify the manufacturer or importer in writing, and give him not less than thirty days thereafter in which to comply with the requirements of this act, but there shall be no prosecution in relation to the quality of the fertilizer or fertilizing material if the same shall be found substantially equivalent to the statement of analysis made by the manufacturer or importer.

SECT. 8. Sections eleven to sixteen inclusive of chapter sixty of the Public Statutes are hereby repealed.

SECT. 9. This act shall take effect on the first day of September in the year eighteen hundred and eighty-eight. [*Approved May 3, 1888.*]

Instructions issued, at the Beginning of the Season, to Dealers in Commercial Fertilizers.

1. An application for a certificate of compliance with the regulations of the trade in commercial fertilizers and materials used for manurial purposes in this State must be accompanied: —

First, with a distinct statement of the name of each brand offered for sale.

Second, with a statement of the amount of phosphoric acid, of nitrogen and of potassium oxide guaranteed in each distinct brand.

Third, with the fee charged by the State for a certificate, which is five dollars for each of the following articles: nitrogen, phosphoric acid and potassium oxide guaranteed in any distinct brand.

2. The obligation to secure a certificate applies not only to compound fertilizers, but to all substances, single or compound, used for manurial purposes, and offered for sale at ten dollars or more per ton of two thousand pounds.

3. The certificate must be secured annually before the 1st of May.

4. Manufacturers, importers and dealers in commercial fertilizers can appoint in this State as many agents as they desire, after having secured at this office the certificate of compliance with our laws.

5. Agents of manufacturers, importers and dealers in commercial fertilizers are held personally responsible for their transactions, until they can prove that the articles they offer for sale are duly recorded in this office.

6. Manufacturers and importers are requested to furnish a list of their agents.

7. All applications for certificates ought to be addressed to the Director of the Massachusetts State Agricultural Experiment Station.

3. List of Dealers who have secured Certificates for the Sale of Commercial Fertilizers in This State during the Past Year, and the Brands licensed by Each.

E. Frank Coe, New York, N. Y. : —
High-grade Ammoniated Bone Superphosphate.
Fish and Potash.
Potato Fertilizer.
Gold Brand Excelsior Guano.

Standard Fertilizer Company, Boston, Mass. : —
Standard Fertilizer.
Standard Superphosphate.

H. S. Miller & Co., Newark, N. J. : —
Standard Superphosphate of Lime.
Ammoniated Dissolved Bone Phosphate.
Potato Fertilizer.
Ground Bone.

J. E. Soper & Co., Boston, Mass. : —
Cotton-seed Hull Ashes.

Leander Wilcox, Mystic Bridge, Conn. : —
Dry Ground Fish Guano.
Acidulated Fish Guano.

J. M. Butman, Lowell, Mass. : —
Lowell Bone Fertilizer.

J. S. Reese & Co. Baltimore, Md., licensees of Clark's Cove Guano Company, New Bedford, Mass. : —
Bay State Fertilizer.
Concentrated Manure for Corn and Potatoes.
King Philip Alkaline Guano.
Great Planet A. A. Manure.
Fish and Potash.
New England Favorite.
Pilgrim Fertilizer.

E. H. Smith, Northborough, Mass. : —
Steamed Bone.

Whittemore Bros., Wayland, Mass. : —
Whittemore's Complete Manure.

Ames Fertilizer Company, Peabody, Mass. : —
Ames' Bone Fertilizer.

G. E. Holmes, Worcester, Mass. : —
Steamed Bone.

3. List of Dealers who have secured Certificates, etc. — Continued.

J. C. Dow & Co., Boston, Mass. : —
Nitrogenous Superphosphate.
Ground Bone Fertilizer.
Fine-ground Bone.

N. Ward Company, Boston, Mass. : —
High-grade Animal Fertilizer.

Hargrave Manufacturing Company, Fall River, Mass. : —
Steamed Bone.

Bradley Fertilizer Company, Boston, Mass. : —
XL Phosphate.
B. D. Sea-fowl Guano.
Coe's Original Superphosphate of Lime.
Fish and Potash.
Pure Fine-ground Bone.
Bradley's Complete Manures : —
For Potatoes and Vegetables.
For Corn and Grain.
For Top-dressing Grass and Grain.
Bradley's Grass Manure for Top-dressing.
Bradley's Potato Manure.
Nitrate of Soda.
Sulphate of Ammonia.
Muriate of Potash.
Dissolved Bone-black.

A. Lee & Co., Boston, Mass. : —
Lawrence Fertilizer.
Ground Bone.

Lister's Agricultural Chemical Works, Newark, N. J. : —
Standard Superphosphate of Lime.
Ammoniated Dissolved Bone.

W. D. Stewart & Co., Boston, Mass. : —
Soluble Pacific Guano.

Cleveland Dryer Company, Boston, Mass. : —
Cleveland Potato Phosphate.
Cleveland Superphosphate.

Cumberland Bone Company, Portland, Me. : —
Cumberland Superphosphate.
Seeding-down Fertilizer.

3. List of Dealers who have secured Certificates, etc. — Continued.

Read Fertilizer Company, Syracuse, N. Y.:—
Farmers' Friend.
Lion Brand.
High-grade Farmers' Friend Special.
Sampson Brand, or Lion Special.

W. J. Brightman & Co., Tiverton, R. I.:—
Fish and Potash.
Superphosphate.
Dry Ground Fish.

Adams & Thomas, Springfield, Mass.:—
Adams' Market Bone Fertilizer.

L. B. Darling Fertilizer Company, Pawtucket, R. I.:—
Darling's Animal Fertilizer.
Extra Bone Phosphate.
Potato and Root-crop Manure.
Pure Bone.
Muriate of Potash.
Sulphate of Potash.

Joseph Church & Co., Tiverton, R. I.:—
Fish and Potash.
Church's Special.
Church's Standard.
Dried and Ground Fish.

F. C. Sturtevant, Hartford, Conn.:—
Tobacco and Sulphur Fertilizer.

Edmund Hersey, Hingham, Mass.:—
Steamed Bone.

Forest City Wood Ash Company, London, Ontario:—
Unleached Wood Ashes.

C. E. Mayo & Co., Boston, Mass.:—
Mayo's Superphosphate.

Great Eastern Fertilizer Company, Rutland, Vt.:—
Great Eastern General, for Grain and Grass.
Great Eastern Vegetable, Vine and Tobacco Fertilizers.
Great Eastern General, Oats, Buckwheat and Seeding-down Phosphate.

Sandford Winter, Brockton, Mass.:—
Steamed Bone.

3. *List of Dealers who have secured Certificates, etc.* — Continued.

Prentiss, Brooks & Co., Holyoke, Mass. : —
Dry Fish.
Dissolved Bone-black.
Muriate of Potash.
Nitrate of Soda.
Sulphate of Potash.

Mapes Formula and Peruvian Guano Company, New York, N. Y. : —
The Mapes Bone Manures.
Peruvian Guano.
Mapes Superphosphate.
Mapes Special Crop Manures.

Bowker Fertilizer Company, Boston, Mass. : —
Stockbridge Manures.
Hill and Drill Phosphate.
Lawn and Garden Fertilizer.
Ammoniated Bone Fertilizer.
Fish and Potash.
Dry Ground Fish.
Gloucester Fish and Potash.
Fine-ground Bone.
Plain Superphosphate.
Kainite.
Nitrate of Soda.
Dried Blood.
Dissolved Bone-black.
Muriate of Potash.
Sulphate of Potash.

C. A. Bartlett, Worcester, Mass. : —
Pure Ground Bone.
Animal Fertilizer.

W. E. Fyfe & Co., Clinton, Mass. : —
Unleached Wood Ashes.

Quinnipiac Fertilizer Company, New London, Conn. : —
Quinnipiac Phosphate.
Quinnipiac Potato Manure.
Quinnipiac Dry Ground Fish.
Quinnipiac Fish and Potash.
Muriate of Potash.
Sulphate of Potash.

3. List of Dealers who have secured Certificates, etc. — Continued.

John G. Jefferds, Worcester, Mass.: —
Jefferds' Animal Fertilizer.
Jefferds' Fine-ground Bone.

Crocker Fertilizer and Chemical Company, Buffalo, N. Y.: —
New Rival Ammoniated Superphosphate.
Buffalo Superphosphate, No. 2.
Special Potato Manure.
Pure Ground Bone.
Ammoniated Bone Superphosphate.
Potato, Hop and Tobacco Phosphate.
Queen City Phosphate.
Vegetable Bone Superphosphate.
Ammoniated Wheat and Corn Phosphate.

James E. McGovern, Lawrence, Mass.: —
West Andover Market Bone Phosphate.
Fine-ground Bone.

American Manufacturing Company, Boston, Mass.: —
The Allen Fertilizer.

Thomas Hersom & Co., New Bedford, Mass.: —
Fine-ground Bone.
Meat and Bone.

H. J. Baker & Bro., New York, N. Y.: —
A. A. Ammoniated Superphosphate.
Pelican Bone Fertilizer.
Potato Manure.

Munroe, Judson and Stroup, Oswego, N. Y.: —
Unleached Wood Ashes.

The Geo. W. Miles Fertilizer and Oil Company, Milford, Conn.: —
IXL Ammoniated Bone Superphosphate.
Fish and Potash.

Joseph Breck & Son, Boston, Mass.: —
Breck's Lawn and Garden Dressing.

National Fertilizer Company, Bridgeport, Conn.: —
Chittenden's Complete Fertilizer.
Chittenden's Fish and Potash.
Chittenden's Universal Phosphate.
Ground Bone.

Stearns' Fertilizer Company, New York, N. Y.: —
Ammoniated Bone Superphosphate.
American Guano.

3. List of Dealers who have secured Certificates, etc. — Concluded.

Davidge Fertilizer Company, New York, N. Y. : —
Potato Manure.
Vegetator.
Special Favorite.

The Le Page Company, Boston, Mass. : —
Red Star Brand 203 Fertilizer.
Red Star Brand Special Potato Fertilizer.

William Lavery, Amesbury, Mass. : —
Lavery's Superphosphate.
Steamed Bone.

4. *Analyses of Commercial Fertilizers collected during the Past Season in the General Markets by the Agent of the Massachusetts Agricultural Experiment Station.*

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
1	Tuttle's Fish,	Prentiss, Brooks & Co., Holyoke, Mass.,	Hatfield.
3	Whittemore's Complete Manure,	Whittemore Bros., Wayland, Mass.,	Wayland.
4	Lowell Bone Fertilizer,	J. M. Butman, Chelmsford, Mass.,	Chelmsford.
8	Potato Manure,	H. J. Baker & Bro., New York, N. Y.,	Boston.
14	Hill and Drill Phosphate,	Bowker Fertilizer Company, Boston, Mass.,	North Sudbury.
19	Fish and Potash,	Joseph Church & Co , Tiverton, R. I.,	Springfield.
25	Adams' Market Bone Fertilizer,	Adams & Thomas, Springfield, Mass.,	Springfield.
37	Vegetable, Vine and Tobacco Fertilizer,	Great Eastern Fertilizer Company, Rutland, Vt.,	Framingham.
39	Potato and Root Crop Manure,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	North Framingham.
41	Original Bay State Bone Superphosphate,	J. A. Tucker & Co., Boston, Mass.,	Framingham.
44	Ammoniated Bone Superphosphate,	National Fertilizer Company, Bridgeport, Conn.,	Northborough.
54	Darling's Pure Dissolved Bone,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Lawrence.
67	Wilcox's Dry Ground Fish Guano,	Leander Wilcox, Mystic Bridge, Conn.,	Amherst.
77	Quinnipiac Dry Ground Fish,	The Quinnipiac Company, New London, Conn.,	Northampton.
	Bones.		
2	Steamed Bone,	E. H. Smith, Northborough, Mass.,	Northborough.
5	Bone Flour,	H. S. Miller & Co., Newark, N. J.,	Boston.
6	Ground Bone,	H. S. Miller & Co., Newark, N. J.,	Boston.
16	Steamed Bone,	J. G. Jefferds, Worcester, Mass.,	Worcester.
17	Steamed Bone,	C. A. Bartlett, Worcester, Mass.,	Worcester.
18	Steamed Bone,	G. E. Holmes, Worcester, Mass.,	Worcester.
110	S. Winter's Pure Ground Bone,	S. Winter, Brockton, Mass.,	Brockton.

4. *Analyses of Commercial Fertilizers, etc.* — Continued.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
1	Tuttle's Fish,	10.00	7 86	8.24—9.89	0.99	4.07	2.92	7.98	–	5.06	–	–	–
3	Whittemore's Complete Manure,	15.11	2.68	2.47—3.3	7.68	6.52	2.02	16.22	12—14	14.20	8—12	3.71	3—4
4	Lowell Bone Fertilizer,	11.46	2.22	2—2.5	5.19	8.57	2.23	15.99	11—16.5	13.76	9—13.5	2.23	2—3.5
8	Potato Manure,	10.62	3.91	3.3	5.36	1.06	0.91	7.33	–	6.42	5.75	9.32	10
14	Hill and Drill Phosphate,	11.15	2.68	2.5—3.25	6.01	1.84	6.09	13.94	12—14	7.85	8—10	2.15	2—3
19	Fish and Potash,	21.74	3.16	3.3—4.12	1.16	2.52	1.57	5.25	5—6	3.68	–	4.03	3—4
25	Adams' Market Bone Fertilizer,	12.77	2.52	2.5—3.5	0.32	3.84	6.42	10.58	8—10	4.16	6—8	5.12	3—5
37	Vegetable, Vine and Tobacco Fertilizer,	15.69	2.06	2.06—2.88	7.16	0.36	2.23	9.75	9—13	7.52	8—11	5.42	6—8
39	Potato and Root Crop Manure,	13.92	2.98	2.88—4.12	3.25	5.09	3.25	11.59	10—12	8.34	–	7.88	7—9
41	Original Bay State Bone Superphosphate,	20.72	2.70	2.47—2.88	2.64	4.70	3.15	10.49	10—12	7.34	9—9.5	2.95	2—3
44	Ammoniated Bone Superphosphate,	17.46	2.26	1.65—2.47	6.70	3.36	0.97	11.03	9—11	10.06	7—8	2 71	2—4
54	Darling's Pure Dissolved Bone,	11.88	2.10	2.06—2.88	3.61	12.99	3.51	20.11	–	16.60	14—16	–	–
67	Wilcox's Dry Ground Fish Guano,	8.22	7.86	8—11	0.62	3.91	3.02	7.55	–	4.53	4—6	–	–
7	Quinnipiac Dry Ground Fish,	10.00	7.94	7.5—10	0.64	3.37	2.85	6.86	7—10	4.01	4—6	–	–
	Bones.											Mechanical Analyses.	
												Fine.	Fine Medium.	Medium.	Coarse Medium.
2	Steamed Bone,	6.13	3.76	3.5—4	0.43	7.41	14.42	22.26	21—23	7.84	–	37.34	28.74	29.78	4.14
5	Bone Flour,	3.45	2.88	2.88—3.30	0.20	11.21	21.11	32.52	20—25	11.41	–	89.63	10.37	–	–
6	Ground Bone,	8.23	2.76	2.7—2.9	0.26	4.65	19.78	24.69	12—14	4.91	–	55.56	21.02	14.52	8 90
16	Steamed Bone,	5.75	3.42	3.3—4.12	0.54	11.72	17.42	29.68	27—30	12.26	–	73.05	19.00	7.95	–
17	Steamed Bone,	7.19	2.41	2.3—2.5	0.43	10.50	15.17	26.10	26—28	10.93	8—10	58.00	21.30	20.70	–
18	Steamed Bone,	5.77	2.82	2.5—3.5	1.36	3.09	16.91	21.36	22—24	4.45	–	48.31	22.70	18.80	10.19
110	S. Winter's Pure Ground Bone,	8.62	3.16	2.5—3.5	0.43	10.35	12.32	23.60	22—24	10.78	–	62.91	22.66	10.38	4.05

4. *Analyses of Commercial Fertilizers, etc.* — Continued.

Laboratory Number.	Name of Brand.	Name of Manufacturer	Sampled at—
	Compound Fertilizers.		
7	The Allen Fertilizer,	American Manufacturing Company, Boston, Mass.,	Boston.
24	Mapes' Potato Manure,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Springfield.
26	Sampson Brand, or Lion Special,	Read Fertilizer Company, New York, N. Y.,	Lee.
27	Farmer's Friend Special,	Read Fertilizer Company, New York, N. Y.,	Lee.
36	Potato Manure,	Bradley Fertilizer Company, Boston, Mass.,	North Adams.
46	Americus Ammoniated Bone Superphosphate,	Williams & Clark Co., New York, N. Y.,	Northborough.
93	Brightman's Dry Ground Fish,	W. J. Brightman & Co., Tiverton, R. I.,	Fall River.
95	Bay State Fertilizer,	John S. Reese & Co., Baltimore, Md.,	New Bedford.
96	Reese's Concentrated Manure for Corn and Potatoes,	John S. Reese & Co., Baltimore, Md.,	New Bedford.
127	Fine-ground Dry Fish,	Bowker Fertilizer Company, Boston, Mass.,	Northampton.
	Chemicals.		
72	Sulphate of Ammonia,	The Quinnipiac Company, New London, Conn., Agents,	Northampton.
73	Sulphate of Potash,	The Quinnipiac Company, New London, Conn., Agents,	Northampton.
74	Muriate of Potash,	The Quinnipiac Company, New London, Conn., Agents,	Northampton.
86	Muriate of Potash,	Bradley Fertilizer Company, Boston, Mass., Agents,	Worcester.
124	Sulphate of Potash,	Bowker Fertilizer Company, Boston, Mass., Agents,	Northampton.
125	Nitrate of Soda,	Bowker Fertilizer Company, Boston, Mass., Agents,	Northampton.
	Bones.		
31	Pure Raw Ground Bone,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Lee.
58	McGovern's Ground Bone,	James E. McGovern, West Andover, Mass.,	West Andover.
103	Pure Fine-ground Bone,	Thos. Hersom & Co, New Bedford, Mass.,	New Bedford.
104	Meat and Bone,	Thos. Hersom & Co., New Bedford, Mass.,	New Bedford.

4. *Analyses of Commercial Fertilizers, etc.* — Continued.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.		Mechanical Analyses.			
								Total.		Available.							
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Fine.	Fine Medium.	Medium.	Coarse Medium.
	Compound Fertilizers.																
7	The Allen Fertilizer,	7.15	2.22	2.06—2.47	5.12	2.81	3.58	11.51	6—10	7.93	5—8	5.35	4—6				
24	Mapes' Potato Manure,	9.09	3.76	3.71—4.12	5.85	3.06	2.53	11.44	–	8.91	8	5.68	6—8				
26	Sampson Brand, or Lion Special,	10.12	2.80	2.47—3.30	6.06	2.66	2.60	11.32	10—12	8.72	8—10	4.18	-*				
27	Farmer's Friend Special,	13.70	4.30	3.3—4.12	3.40	1.90	2.56	7.86	6—7	5.30	5—6	10.02	10—12				
36	Potato Manure,	12.30	2.19	2.5—3.25	6.67	1.46	1.71	9.84	8—11	8.13	6—8	5.27	5—6				
46	Americus Ammoniated Bone Superphosphate,	15.70	1.94	2—3	8.96	1.27	1.80	12.03	11—16	10.23	9—11	2.36	2—3				
93	Brightman's Dry Ground Fish,	9.47	8.36	8.24—9.88	0.49	4.71	5.09	10.29	–	5.20	–	–	–				
95	Bay State Fertilizer,	9.86	2.38	2.4—3.3	6.52	6.94	3.48	16.94	–	13.46	9—12	1.93	2—3				
96	Reese's Concentrated Manure for Corn and Potatoes,	10.82	3.16	2.88—3.5	3.33	5.80	5.12	14.25	–	9.13	6—8	7.26	7.5—9.5				
127	Fine-ground Dry Fish,	9.50	8.20	8—10	0.59	4.56	2.17	7.32	7—8	5.15	–	–	–				
	Chemicals.																
72	Sulphate of Ammonia,	2.00	20.40	19.76—21.42	–	–	–	–	–	–	–	–					
73	Sulphate of Potash,	5.94	–	–	–	–	–	–	–	–	–	24.80	-*				
74	Muriate of Potash,	2.50	–	–	–	–	–	–	–	–	–	48.56	-†				
86	Muriate of Potash,	3.50	–	–	–	–	–	–	–	–	–	50.12	48—55				
124	Sulphate of Potash,	5.27	–	–	–	–	–	–	–	–	–	24.52	24—26*				
125	Nitrate of Soda,	1.74	15.10	14.82—15.64	–	–	–	–	–	–	–	–	–				
	Bones.																
31	Pure Raw Ground Bone,	7.69	3.66	2.88—3.3	0.18	7.40	16.96	24.54	25	7.58	–	34.05	27.55	22.00	16.40		
58	McGovern's Ground Bone,	12.89	1.66	1.5—2.25	0.20	6.84	12.87	19.91	18—20	7.04	–	39.85	32.30	18.35	9.50		
103	Pure Fine-ground Bone,	3.32	1.80	1.75—2.25	0.24	8.02	22.03	30.29	27—30	8.26	–	51.32	33.83	13.04	1.81		
104	Meat and Bone,	4.45	4.76	4—5	0.28	0.76	11.37	18.41	18—20	7.04	–	–	–	–	–		

* Sulphate of potash, the source of potash.

† Guaranteed 80—85 per cent. muriate of potash.

4. *Analyses of Commercial Fertilizers, etc.* — Continued.

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at—
21	Tobacco and Sulphur Lawn Fertilizer,	F. C. Sturtevant, Hartford, Conn.,	Springfield.
32	Potato, Hop and Tobacco Phosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Lee.
35	XL Superphosphate of Lime,	Bradley Fertilizer Company, Boston, Mass.,	North Adams.
40	Darling's Animal Fertilizer,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	North Framingham.
42	Ammoniated Wheat and Corn Manure,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Framingham.
47	The Ames Fertilizer,	Ames Fertilizer Company, Peabody, Mass.,	North Sudbury.
48	The N. Ward Company's High-grade Animal Fertilizer,	The N. Ward Company, Boston, Mass.,	Boston.
49	Red Star Brand 203 Fertilizer for General Crops,	Le Page Company, Boston, Mass.,	Woburn.
56	The Lawrence Fertilizer,	A. Lee & Co., Lawrence, Mass.,	Lawrence.
60	Lister's Success Fertilizer,	Lister Agricultural and Chemical Works, Newark, N. J.,	Lowell.
83	Cumberland Seeding-down Fertilizer,	Cumberland Bone Company, Portland, Me.,	Jefferson's.
97	Clark's Cove King Philip Alkaline Guano,	John S. Reese & Co., Baltimore, Md., Licensees,	New Bedford.
98	Clark's Cove Great Planet A. A. Manure,	John S. Reese & Co., Baltimore, Md., Licensees,	New Bedford.
105	Standard Fertilizer,	Standard Fertilizer Company, Boston, Mass.,	Taunton.
106	Potato Fertilizer,	E. Frank Coe, New York City, N. Y.,	Taunton.
115	Cumberland Superphosphate,	Cumberland Bone Company, Portland, Me.,	Sunderland.
128	Fish and Potash, Anchor Brand,	Bradley Fertilizer Company, Boston, Mass.,	Northampton.
130	Dry Fish Guano,	Bradley Fertilizer Company, Boston, Mass.,	Northampton.
137	Nitrogenous Superphosphate,	J. C. Dow & Co., Boston, Mass.,	Cambridgeport.
146	Soluble Pacific Guano,	W. D. Stewart & Co., Boston, Mass.,	Berlin.
147	Special Favorite,	Davidge Fertilizer Company, New York City, N. Y.,	Barre Plains.

4. *Analyses of Commercial Fertilizers, etc.* — Continued.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
21	Tobacco and Sulphur Lawn Fertilizer,	22.06	1.96	2.38	–	–	–	0.71	0.75	–	–	7.80	7.66
32	Potato, Hop and Tobacco Phosphate,	14.23	2.08	2—3	7.65	1.74	1.78	11.17	11—15	9.39	10—13	4.24	3.5—4.5
35	XL Superphosphate of Lime,	13.87	2.66	2.5—3	7.14	2.46	1.79	11.39	11—14	9.60	9—11	1.91	2—3
40	Darling's Animal Fertilizer,	12.33	2.83	3.3—4.94	4.03	3.69	4.66	12.38	–	7.72	10—12	5.87	4—6
42	Ammoniated Wheat and Corn Manure,	15.61	2.02	2—3	8.47	2.23	0.64	11.31	11—15	10.70	10—13	1.80	1.75—2.93
47	The Ames Fertilizer,	21.22	3.12	2.47—3.3	5.05	4.53	0.42	10.00	8—12	9.58	7—10	1.04	0.75—2
48	N. Ward & Co.'s High-grade Animal Fertilizer,	18.25	3.29	2.88—3.7	5.40	5.64	1.14	12.18	–	11.04	12—14	4.76	4—5
49	Red Star Brand 203 Fertilizer for General Crops,	13.65	3.30	3—4	4.44	2.61	2.14	9.19	10—12	7.05	8—10	4.20	3—4
56	The Lawrence Fertilizer,	14.06	2.32	2.06- 2.88	6.45	6.42	2.56	15.43	–	12.87	10—12	1.94	2—3
60	Lister's Success Fertilizer,	11.99	1.52	1.03—1.65	8.11	1.54	2.25	11.90	–	9.65	10.5—12	1.69	1.5—2
83	Cumberland Seeding-down Fertilizer,	13.89	1.62	1.65	2.35	6.20	6.59	18.14	18—20	8.55	5—9	1.05	1
97	Clark's Cove King Philip Alkaline Guano,	12.30	1.70	1.24—1.65	5.20	3.04	2.20	10.44	–	8.24	6.5—8	3.42	3—4
98	Clark's Cove Great Planet A. A. Manure,	10 21	3.22	2.88—3.71	4.89	2.24	2.67	9.80	–	7.13	6—8	7.85	7.5—9.5
105	Standard Fertilizer,	13.85	2.66	2—3	7.79	1.63	1.54	10.96	10—15	9.42	8—12	2.09	2—3
106	Potato Fertilizer,	12.35	2.16	2—2.5	6.75	2.89	1.46	11.10	–	9.64	8—11	6.89	6
115	Cumberland Superphosphate,	14.28	2.20	2—3	5.01	2.28	8.09	15 38	12—14	7.29	9—13	2.24	2—3
128	Fish and Potash, Anchor Brand,	18.74	3.72	3.25—4.25	4.22	1.44	1.43	7.09	–	5.66	3—5	4.30	3—5
130	Dry Fish Guano,	12.38	8.48	8.24—9.88	0.08	3.55	4.07	7.70	6—8	3.63	–	–	–
137	Nitrogenous Superphosphate,	15.84	2.48	2.06—2.88	5 32	4.41	2.17	11.90	–	9.73	8—10	3.17	3—4
146	Soluble Pacific Guano,	17.28	2.60	2.25—3	7.93	1.89	2.56	12.38	10.5—16	9.82	8.5—11	2.42	2—3
147	Special Favorite,	18.38	1.64	1.24—2.06	9.98	1.40	0.03	11.41	11—14	11.38	10—12	1.82	1.5—2.5

4. *Analyses of Commercial Fertilizers, etc.* — Continued.

Laboratory Number	Name of Brand.	Name of Manufacturer.	Sampled at —
29	Farmer's Friend Superphosphate,	Read Fertilizer Company, New York, N. Y.,	Lee.
30	Ammoniated Bone Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Lee.
45	Chittenden's Potato Manure,	National Fertilizer Company, Bridgeport, Conn.,	Northborough.
49	Red Star Brand 203 Fertilizer for General Crops,	Le Page Company, Boston, Mass.,	Woburn.
52	Cleveland Potato Phosphate,	Cleveland Dryer Company, Cleveland, Ohio,	South Framingham.
64	Mapes' Complete Manure for General Use,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Lowell.
90	Quinnipiac Phosphate,	The Quinnipiac Company, New London, Conn.,	Fall River.
119	Fish and Potash,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
132	Tobacco Manure, Wrapper Brand,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Northampton.
148	IXL Ammoniated Bone Superphosphate,	The Miles Fertilizer and Oil Company, Milford, Conn.,	Northampton.
151	Soluble Bone Phosphate,	Davidge Fertilizer Company, New York, N. Y.,	Williamsburg.
	Bones.		
20	Ground Bone,	H. J. Baker & Bro., New York, N. Y.,	Springfield.
55	Royal Pure Ground Bone,	A. Lee & Co., Lawrence, Mass.,	Lawrence.
59	Chittenden's Ground Bone,	National Fertilizer Company, Bridgeport, Conn.,	Lawrence.
61	Lister's Celebrated Bone,	Lister Agricultural and Chemical Works, Newark, N. J.,	Lowell.
71	Quinnipiac Pure Bone Meal,	The Quinnipiac Company, New London, Conn.,	Northampton.
78	Bowker's Fine-ground Bone,	Bowker Fertilizer Company, Boston, Mass.,	Northampton.
89	Hargrave's Bone,	Hargrave Manufacturing Company, Fall River, Mass.,	Fall River.
111	Ground Bone,	Edmund Hersey, Hingham, Mass.,	Hingham.
138	Fine-ground Bone,	J. C. Dow & Co., Boston, Mass.,	Cambridgeport.
141	Pure Ground Bone,	Wm. Lavery, Amesbury, Mass.,	Amesbury.

4. *Analyses of Commercial Fertilizers, etc.* — Continued.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
29	Farmer's Friend Superphosphate,	14.80	2.60	2.06—2.47	6.98	3.00	2.70	12.68	11—13	9.98	9—11	2.40	-*
30	Ammoniated Bone Superphosphate,	11.77	3.25	2.88—3.71	6.54	0.49	3.42	10.45	11—15	7.03	10—13	1.41	1—2
45	Chittenden's Potato Manure,	10.10	3.30	3.29—4.12	3.68	4.08	4.64	12.40	-	7.76	6—8	6.28	6—8
49	Red Star Brand 203 Fertilizer for General Crops,	13.65	3.30	3—4	4.44	2.61	2.14	9.19	10—12	7.05	8—10	4.20	3—4
52	Cleveland Potato Phosphate,	16.97	2.18	2.05—2.85	7.89	1.28	0.55	9.72	-	9.17	8—10	3.76	3.25—4.25
64	Mapes' Complete Manure for General Use,	15.47	3.44	3.29—4.12	3.79	4.85	3.33	11.97	10—12	8.64	8—10	3.96	4—5
90	Quinnipiac Phosphate,	21.76	2.80	2.5—3.5	2.71	7.14	0.77	10.62	10—16	9.85	9—13	2.42	2—3
119	Fish and Potash,	6.02	3.70	3.29—4.12	2.62	2.78	1.09	6.49	5—6	5.40	-	5.03	4—6
132	Tobacco Manure, Wrapper Brand,	1.49	5.98	6.18	0.92	3.50	2.56	6.98	4.5	4.42	-	11.05	10.50
148	IXL Ammoniated Bone Superphosphate,	15.14	2.96	2.06—3.30	8.64	0.81	0.19	9.64	9—14	9.45	8—12	2.27	1.5—3
151	Soluble Bone Phosphate,	11.60	-	-	8.30	2.48	0.22	11.00	11—14	10.78	10—12	1.90	1.5—2.5
												Mechanical Analyses.	
												Fine.	Fine Medium.
	Bones.												
20	Ground Bone,	11.07	4.22	3.85	0.08	6.14	14.43	20.65	23.75	6.22	-	52.65	41.90
55	Royal Pure Ground Bone,	9.76	3.80	4—5	0.16	11.14	13.50	24.80	25—27	11.30	-	39.10	25.50
59	Chittenden's Ground Bone,	6.00	3.04	2.88—3.71	0.15	5.10	19.34	24.59	20—24	5.25	-	18.64	31.78
61	Lister's Celebrated Bone,	6.16	2.50	2.47—2.88	0.43	7.63	6.73	14.79	12—18	8.06	-	31.96	28.82
71	Quinnipiac Pure Bone Meal,	19.23	2.76	2.47—4.12	0.20	11.43	12.22	23.85	22—25	11.63	-	32.74	33.18
78	Bowker's Fine-ground Bone,	5.81	3.20	2.47—3.30	0.33	8.23	13.19	21.75	18—22	8.56	-	57.32	23.19
89	Hargrave's Bone,	11.48	3.10	2.5—3.5	-	7.58	17.78	25.36	23—25	7.58	-	31.12	24.78
111	Ground Bone,	2.99	2.90	3—4	0.38	9.06	18.64	28.08	19—25	9.44	-	46.37	30.08
138	Fine-ground Bone,	2.67	2.08	1.65—2.47	0.61	6.74	19.52	26.87	24—26	7.35	-	70.13	28.70
114	Pure Ground Bone,	14.68	2.52	2—3	-	4.94	9.34	14.28	12—18	4.94	-	47.10	44.19

Laboratory Number.	Name of Brand.	Mechanical Analyses.	
		Medium.	Coarse Medium.
29	Farmer's Friend Superphosphate,	5.45	-
30	Ammoniated Bone Superphosphate,	18.30	17.10
45	Chittenden's Potato Manure,	18.64	11.49
49	Red Star Brand 203 Fertilizer for General Crops,	19.01	20.21
52	Cleveland Potato Phosphate,	18.69	15.39
64	Mapes' Complete Manure for General Use,	13.89	5.60
90	Quinnipiac Phosphate,	18.22	25.88
119	Fish and Potash,	9.64	3.91
132	Tobacco Manure, Wrapper Brand,	1.17	-
148	IXL Ammoniated Bone Superphosphate,	8.71	-
151	Soluble Bone Phosphate,		
	Bones.		
20	Ground Bone,		
55	Royal Pure Ground Bone,		
59	Chittenden's Ground Bone,		
61	Lister's Celebrated Bone,		
71	Quinnipiac Pure Bone Meal,		
78	Bowker's Fine-ground Bone,		
89	Hargrave's Bone,		
111	Ground Bone,		
138	Fine-ground Bone,		
114	Pure Ground Bone,		

* Sulphate of potash, the source of potash.

4. *Analyses of Commercial Fertilizers, etc.* — Continued.

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
9	Lawn Dressing,	H. J. Baker & Bro., New York, N. Y.,	Boston.
10	A. A. Ammoniated Superphosphate,	H. J. Baker & Bro., New York, N. Y.,	Boston.
11	Square Brand Bone and Potash,	Bowker Fertilizer Company, Boston, Mass.,	North Sudbury.
12	Ammoniated Bone Fertilizer,	Bowker Fertilizer Company, Boston, Mass.,	North Sudbury.
13	Stockbridge's Manure for Asparagus,	Bowker Fertilizer Company, Boston, Mass.,	North Sudbury.
15	Stockbridge's Manure for Vegetables and Potatoes,	Bowker Fertilizer Company, Boston, Mass.,	North Sudbury.
28	Lion Brand,	Read Fertilizer Company, New York, N. Y.,	Lee.
38	Grass and Grain Fertilizer,	Great Eastern Fertilizer Company, Rutland, Vt.,	Framingham.
50	Mayo's Superphosphate,	C. E. Mayo & Co., Boston, Mass.,	Woburn.
53	Breck's Lawn Dressing,	Bowker Fertilizer Company, Boston, Mass.,	Boston.
63	Chittenden's Universal Phosphate,	National Fertilizer Company, Bridgeport, Conn.,	Lawrence.
66	Mapes' Grass and Grain Spring Top-dressing,	Mapes' Formula and Peruvian Guano Company, New York, N. Y.,	Lowell.
68	Wilcox Prepared Fertilizer,	Leander Wilcox, Mystic Bridge, Conn.,	Amherst.
69	Wilcox Fish and Potash,	Leander Wilcox, Mystic Bridge, Conn.,	Amherst.
75	Quinnipiac Fish and Potash, Cross Brand,	The Quinnipiac Company, New London, Conn.,	Northampton.
79	Bowker's Square Brand Fish and Potash,	Bowker Fertilizer Company, Boston, Mass.,	Northampton.
84	Jefferd's Animal Fertilizer with Potash,	J. G. Jefferds, Worcester, Mass.,	Worcester.
85	Bartlett's Animal Fertilizer with Potash,	C. A. Bartlett, Worcester, Mass.,	Worcester.
99	Clark's Cove Fish and Potash,	John S. Reese & Co., Baltimore, Md.,	New Bedford.
100	Clark's Cove New England Favorite,	John S. Reese & Co., Baltimore, Md.,	New Bedford.
102	Red Star Brand Special for Potatoes,	Le Page Company, Boston, Mass.,	New Bedford.

4. *Analyses of Commercial Fertilizers, etc.* — Continued.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
9	Lawn Dressing,	18.87	4.16	3.50	4.66	1.75	0.38	6.79	–	6.41	4.75	6.81	7.00
10	A. A. Ammoniated Superphosphate,	14.55	2.63	2.47—3.30	10.08	0.82	0.14	11.04	–	10 90	10—12	2.38	2—3
11	Square Brand Bone and Potash,	6 00	1.56	1.65—2.47	0.92	5.78	7.19	13.89	–	6.70	12—15	1.96	2—3
12	Ammoniated Bone Fertilizer,	12.85	2.21	2—3	2.72	3.95	5.73	12.40	10—12	6.67	8—10	2.43	2—3
13	Stockbridge's Manure for Asparagus,	11.94	3.54	3.25—4.25	2.93	2.48	4.73	10.14	8—10	5.41	7—8	5.06	5—6
15	Stockbridge's Manure for Vegetables and Potatoes,	10.97	4.12	3.25—4.25	2.87	4.72	4.58	12.17	8—10	7.59	7—8	5.23	5—6
28	Lion Brand,	14.16	1.12	0.82—1.65	5.86	3.33	1.91	11.10	10—12	9.19	8—10	4 22	-*
38	Grass and Grain Fertilizer,	13.61	3.19	2.88—3.71	6.42	1.67	2.12	10.21	9—15	8.09	8—12	1.73	2—4
50	Mayo's Superphosphate,	17.11	2.50	2.05—2.85	8.15	0.85	1.23	10.23	10—14	9.00	9—12	2.46	2.5—3.5
53	Breck's Lawn Dressing,	9.41	3.84	4.12—4.94	2.20	3.09	6.97	12.26	–	5.29	5—6	5.03	5—6
63	Chittenden's Universal Phosphate,	15.15	2.65	2.06—2.88	4.95	3.62	2.57	11.14	11—12	8.57	9—11	3.19	2—3
66	Mapes Grass and Grain Spring Top-dressing,	12.00	4.16	4.12—5.77	3.35	3.80	2.60	9.75	7—9	7.15	7	5.44	5—7
68	Wilcox Prepared Fertilizer,	24.76	3.51	3.30—4.12	3.38	2.07	1.51	6.96	–	5.45	5.5—7.5	3 65	–
69	Wilcox Fish and Potash,	21.40	3.86	3.5—4.5	2.82	2.46	1.25	6.53	5—7	5.28	–	4.02	4—6
75	Quinnipiac Fish and Potash, Cross Brand,	21.24	3.37	3.25—4.25	2.17	2.82	1.71	6.70	–	4.99	2—5	4.16	3—5
79	Bowker's Square Brand Fish and Potash,	14.50	2 64	2.25—3.25	3.74	2.75	2 87	9.36	8—10	6.49	–	4.01	4—6
84	Jefferd's Animal Fertilizer with Potash,	4.93	5 60	4.12—5.77	0.13	12.05	5.78	17.96	14—16	12.18	–	5.28	5—7
85	Bartlett's Animal Fertilizer with Potash,	4.34	4.46	3.30—4.12	0.15	5.83	7.00	12.98	16—18	5.98	–	5.84	7—8
99	Clark's Cove Fish and Potash,	13.26	3.28	2.47—4.12	2.57	3.85	2.71	9.13	–	6.42	6—8	4.90	3—5
100	Clark's Cove New England Favorite,	13.19	2.54	2.27—2.68	5.86	3.42	3.67	12.95	–	9.28	9—11	2.03	2—2.5
102	Red Star Brand Special for Potatoes,	15.87	2.69	3—4	2.33	3.56	3 15	9.04	8—10	5.89	6—8	4.70	5—6

* Sulphate of potash, the source of potash

4. *Analyses of Commercial Fertilizers, etc.* — Continued.

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at—
	Compound Fertilizers.		
107	High-grade Ammoniated Bone Superphosphate,	E. Frank Coe, New York, N. Y.,	Taunton.
108	Standard Ground Bone and Potash,	B. Randall, 113 Central St., Boston, Mass.,	Boston.
112	Potato Fertilizer,	H. S. Miller & Co., Newark, N. J.,	Sunderland.
113	Standard Superphosphate,	H. S. Miller & Co., Newark, N. J.,	Sunderland.
116	Onion, Potato and Tobacco Manure,	The Quinnipiac Company, New London, Conn.,	South Deerfield.
117	Pequot Fish and Potash,	The Quinnipiac Company, New London, Conn.,	South Deerfield.
118	Potato Manure,	The Quinnipiac Company, New London, Conn ,	South Deerfield.
120	Phelps' Phosphate,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
121	Phelps' Complete Manure for Top-dressing,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
129	Complete Manure for Top-dressing Grass and Grain,	Bradley Fertilizer Company, Boston, Mass.,	Northampton.
131	Fish and Potash, "A" Brand,	Bradley Fertilizer Company, Boston, Mass ,	Northampton.
133	Grass and Grain Spring Top-dressing,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Northampton.
135	Fish and Potash, "D" Brand,	Joseph Church & Co., Tiverton, R. I.,	Stoughton.
136	Imperial Bone Superphosphate,	J. A. Tucker & Co., Boston, Mass.,	Boston.
139	Ground Bone Fertilizer,	J. C. Dow & Co., Boston, Mass.,	Cambridgeport.
140	Standard Superphosphate,	Standard Fertilizer Company, Boston, Mass.,	Ipswich.
142	Lavery's Superphosphate,	Wm. Lavery, Amesbury, Mass.,	Amesbury.
143	Ammoniated Dissolved Bone Phosphate,	H. S. Miller & Co., Newark, N. J.,	Clinton.
144	Harvest Queen Phosphate,	H. S. Miller & Co., Newark, N. J.,	Clinton.
145	Vegetable Bone Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Clinton.
149	Fish and Potash,	The Miles Fertilizer and Oil Company, Milford, Conn.,	Northampton.

4. *Analyses of Commercial Fertilizers, etc.* — Continued.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
107	High-grade Ammoniated Bone Superphosphate,	13.46	2.24	2—2.5	7.92	2.29	2.11	12.32	11—15	10.21	9—12	1.78	2
108	Standard Ground Bone and Potash,	10.18	2.64	1.6—2.5	0.95	7.89	7.79	16.63	13—16	8.84	5—7	1.88	2
112	Potato Fertilizer,	9.77	4.86	3.71—4.12	3.66	2.89	0.91	7.45	–	6.55	8.5—10	7.66	7—8
113	Standard Superphosphate,	16.74	2.80	2.35—2.68	9.30	1.06	0.40	10.76	11.5—14.5	10.36	10—12	2.20	1.5—2
116	Onion, Potato and Tobacco Manure,	16.05	3.26	3.25—4.25	2.39	7.04	1.62	11.05	9—14	9.43	8—11	6.52	7—8
117	Pequot Fish and Potash,	9.50	2.86	2.5—3.25	0.20	4.28	3.67	8.15	–	4.48	3—5	5.15	4—6
118	Potato Manure,	14.04	3.57	2.5—3.25	1.71	4.97	3.11	9.79	6—11	6.68	5—9	5.81	5—6
120	Phelps' Phosphate,	15.51	2.78	2.47—3.30	10.26	0.69	0.33	11.28	10—12	10.95	–	3.02	3—4
121	Phelps' Complete Manure for Top dressing,	9.83	5.63	4.12—4.94	5.23	2.46	0.32	8.01	7—8	7.69	4—5	8.27	8—10
129	Complete Manure for Top-dressing Grass and Grain,	10.29	4.94	4.94—5.77	3.53	3.02	0.26	6.81	–	6.55	5—7	3.13	2.5—3.5
131	Fish and Potash, "A" Brand,	23.34	2.86	2—3	3.94	2.60	0.96	7.50	–	6.54	4—6	3.94	4—6
133	Grass and Grain Spring Top dressing,	10.93	5.02	4.12—5.77	3.93	2.66	2.56	9.15	7—9	6.59	7	6.26	5—7
135	Fish and Potash, "D" Brand,	18.59	3.36	3.30—4.12	1.05	2.92	1.66	5.63	5—6	3.97	–	4.62	3—4
136	Imperial Bone Superphosphate,	18.48	2.50	2.06—2.47	0.86	5.60	3.89	10.35	9—10	6.46	8—9	2.45	2.5—3
139	Ground Bone Fertilizer,	5.65	1.73	1.65—2.47	0.43	5.62	16.11	22.16	18—22	6.05	–	2.86	3—4
140	Standard Superphosphate,	12.93	2.32	2.5—3.5	8.80	2.02	1.19	12.01	11—16	10.82	9—13	1.83	2—3
142	Lavery's Superphosphate,	11.86	2.04	1.97	2.28	4.39	5.71	12.38	10.17	6.67	7.08	2.60*	2.36
143	Ammoniated Dissolved Bone Phosphate,	11.50	1.82	1.65—2.06	7.57	2.18	0.46	10.21	9.5—12.5	9.75	8—10	1.90	1.5—2
144	Harvest Queen Phosphate,	6.22	1.04	0.82—1.65	3.10	8.11	1.25	12.46	10—12	11.21	10—12	1.83	1.5—2
145	Vegetable Bone Superphosphate,	13.24	5.80	4.94—5.77	4.20	3.82	0.42	8.44	9—7	8.02	6—7	6.10	-*
149	Fish and Potash,	21.50	3.06	3.30—4.94	5.91	0.12	1.13	7.16	–	6.03	5—8	4.10	4—6

* Sulphate of potash, the source of potash.

4. *Analyses of Commercial Fertilizers, etc.* — Continued.

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
22	Lawn and Garden Dressing,	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
23	Stockbridge's Manure for Top-dressing,	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
34	Original Coe's Superphosphate of Lime,	Bradley Fertilizer Company, Boston, Mass.,	Lee.
43	Special Potato Manure,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Framingham
62	Darling's Fertilizer for Lawn and Gardens,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Lowell.
65	Mapes' Fruit and Vine Manure,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Lowell.
70	Ammoniated Dissolved Bone,	Quinnipiac Company, New London, Conn.,	Northampton.
80	Stockbridge's Manure for Onions,	Bowker Fertilizer Company, Boston, Mass.,	Northampton.
88	Potato Phosphate,	Williams & Clark Co., New York, N. Y.,	Worcester.
91	Quinnipiac Market Garden Manure,	The Quinnipiac Company, New London, Conn.,	Fall River.
92	Brightman's Fish and Potash,	W. J. Brightman & Co., Tiverton, R. I.,	Fall River.
94	Complete Grass Manure,	H. J Baker & Bro., New York, N. Y.,	Fall River.
101	Clark's Cove Pilgrim Fertilizer,	John S. Reese & Co., Baltimore, Md., Licensees,	New Bedford.
109	Market Garden Fertilizer,	B. Randall, Boston, Mass.,	Boston.
114	Tobacco Fertilizer,	H. S. Miller & Co., Newark, N. J.,	South Deerfield.
122	Phelps' Complete Manure for Corn,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
123	Phelps' Complete Manure for Potatoes,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
150	Special Favorite,	Davidge Fertilizer Company, New York, N. Y.,	Williamsburg.

4. Analyses of Commercial Fertilizers, etc. — Concluded.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
22	Lawn and Garden Dressing,	10.35	4.29	4—5	3.44	2.70	3.98	10.12	-	6.14	5—6	4.46	5—6
23	Stockbridge's Manure for Top-dressing,	6.20	4.56	5—6	3.25	3.68	5.40	12.33	-	6.93	6—7	4.76	5—6
34	Original Coe's Superphosphate of Lime,	14.89	2.34	2.05—2.85	8 84	1.36	1.66	11.86	10—14	10.20	8—11	1.87	1—2
43	Special Potato Manure,	21.07	3.18	3.7—4.5	5.48	1.97	2.09	9.54	7—10	7.45	6—8	4.86	-*
62	Darling's Fertilizer for Lawn and Gardens,	16.40	4 22	4—6	3.24	6.82	1.94	12.00	10—12	10.06	-	5.99	5—6
65	Mapes' Fruit and Vine Manure,	14.10	2.30	1.65—2.47	7.11	0.36	0.51	7.98	7—9	7.47	-	12.22	11—12
70	Ammoniated Dissolved Bone,	14.69	1.94	1.65—2.47	3.52	6.24	1.70	11.46	11—14	9.76	9—12	2 54	4—6
80	Stockbridge's Manure for Onions,	18 87	3.05	3.25—4.25	5.83	3.05	1.15	10.03	8—10	8.88	7—8	4.58	5—6
88	Potato Phosphate,	11.28	2.52	2—3	5.89	2.64	1.88	10.41	-	8.53	6—8	6 12	6—8
91	Quinnipiac Market Garden Manure,	16.07	3.68	3.25—4.25	3.09	6 30	1.19	10 58	-	9.39	8—11	6.34	7—8
92	Brightman's Fish and Potash,	20.91	3.80	2.47—4.12	1.79	2.54	1.30	5.63	6—7	4 33	2—3	3.67	2—3
94	Complete Grass Manure,	18.70	3.20	3.71	4.82	1.60	0.28	6.70	-	6.42	5	8 35	7
101	Clark's Cove Pilgrim Fertilizer,	17.56	1.36	1.03—2.68	5.53	1.95	1.97	9.45	-	7.48	6.5—7.5	3.11	2.5—3.5
109	Market Garden Fertilizer,	17.89	3.76	1.65—2.47	4 41	5.52	0.29	10.22	10—16	9.93	8—10	2.97	2—4
114	Tobacco Fertilizer,	19.24	5.30	5.35	0.36	0.75	1.13	2.24	-	1.11	3—4	7.89	6.5
122	Phelps' Complete Manure for Corn,	13.59	4.36	4.12—4.94	7.41	3.90	0 56	11.87	8—10	11.31	6—7	8.31	6—7
123	Phelps' Complete Manure for Potatoes,	12.03	4.52	3.30—4.12	5.88	2 39	0.42	10.16	6—8	8.27	5—6	10.16	8—10
150	Special Favorite,	16.82	1.80	1.24—2.06	7.70	3.73	1.15	12.58	11—14	11.43	10—12	1.66	1.5—2.5

* Sulphate of potash, the source of potash.

Agricultural Chemicals.

Muriate of Potash.

[I. and II. sent on from Amherst, Mass.; III. sent on from Concord, Mass.; IV. and V. sent on from Eastham, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	0.43	1.90	0.64	2.97	2.10
Potassium oxide,	50.97	49.20	49.68	47.24	49.20
Chlorine,	48.64	53.00	50.00	38.83	44.85
Insoluble matter,	0.11	0.11	Trace.	0.54	0.42

[I. and II., sulphate of potash and magnesia, sent on from Amherst, Mass.; III., sulphate of potash, sent on from Eastham; IV., sulphate of potash, sent on from Feeding Hills.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	14.70	17.35	8.26	2.54
Magnesium oxide,	6.97	7.02	–	10.88
Potassium oxide,	16.96	29.48	26.60	24.90
Sulphuric acid,	32.97	40.68	41.96	48.32
Insoluble matter,	2.70	1.47	0.51	2.67

Nitrate of Soda.

[I. and II. sent on from Amherst; III. sent on from Eastham; IV. sent on from Concord.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	1.74	1.50	6.62	1.30
Sodium oxide,	38.14	33.63	44.96	–
Nitrogen,	14.44	15.46	14.92	15.48
Insoluble matter,	Trace.	0.10	None.	Trace.

Agricultural Chemicals — Concluded.

Sulphate of Ammonia.

[Two samples from Amherst.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	2.46	2.21
Nitrogen,	20.14	21.30
Sulphuric acid,	60.05	59.37
Insoluble matter,	0.06	Trace.

5. *Analyses of Commercial Fertilizers and Manurial Substances sent on for Examination.*

Wood Ashes.

[I, II. and III. sent on by Geo. A. Tapley, Revere, Mass.; IV. sent on by Coolidge Bros., South Sudbury, Mass.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C,	18.74	12.25	4.08	2.92
Calcium oxide,	28.24	5.08	25.63	37.10
Magnesium oxide,	4.64	0.27	5.64	6.45
Ferric oxide,	1.10	12.36	1.18	1.77
Potassium oxide,	5.94	2.24	5.34	5.42
Phosphoric acid,	2.11	0.46	2.92	2.05
Insoluble matter (before calcination),	10.52	58.45	13.69	15.37
Insoluble matter (after calcination),	8.31	55.19	12.11	13.11

5. *Analyses, etc.* — Continued.

Wood Ashes (Four Samples).

[Sent on by Coolidge Bros., South Sudbury, Mass.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	1.59	1.88	1.66	1.98
Calcium oxide,	41.60	39.89	43.09	40.39
Magnesium oxide,	3.00	4.41	2.33	3.85
Ferric oxide,	0.84	1.07	0.69	0.97
Potassium oxide,	6.96	6.08	5.44	5.18
Phosphoric acid,	1.23	2.06	1.17	1.71
Insoluble matter (before calcination),	11.65	15.87	9.03	12.17
Insoluble matter (after calcination),	11.07	12.96	7.91	10.26

Wood Ashes.

[I. sent on by H. G. Herrick, Lawrence, Mass.; II. sent on by James Logan, Worcester, Mass.; III. sent on by Frank Wheeler, Concord, Mass.; IV. sent on by Anson Wheeler, Concord, Mass.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C,	9.12	0.18	15.60	18.51
Calcium oxide,	31.63	39.39	32.86	31.07
Magnesium oxide,	3.34	3.12	3.81	2.69
Ferric oxide,	1.07	–	–	–
Potassium oxide,	5.88	7.28	5.11	5.84
Phosphoric acid,	2.97	2.10	1.48	2.00
Insoluble matter (before calcination),	18.79	12.80	16.59	8.67
Insoluble matter (after calcination),	12.67	11.94	15.68	6.52

5. *Analyses, etc.* — Continued.

Wood Ashes

[I. from Experiment Station, Amherst, Mass.; II. sent on by C. L. Hartshorn, Worcester, Mass.; III. sent on by L. F. Priest, Rock Bottom, Mass.; IV. sent on by H. F. Cross, Hingham, Mass.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	15.07	0.42	15.70	4.26
Calcium oxide,	31.09	28.34	34.07	20.05
Magnesium oxide,	3.34	2.99	3.57	6.36
Ferric oxide,	–	–	–	–
Potassium oxide,	5.29	8.72	4.64	4.68
Phosphoric acid,	1.37	0.71	1.36	2.88
Insoluble matter (before calcination),	13.20	52.73	12.56	42.30
Insoluble matter (after calcination),	10.22	27.73	11.10	39.98

Wood Ashes.

[I. and II. sent on by W. L. Hubbard, Sunderland, Mass.; III. sent on by W. L. Faxon, Quincy, Mass.; IV. sent on by F. H. Williams, Sunderland, Mass.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	22.29	20.91	4.73	16.54
Calcium oxide,	32.32	29.97	32.94	32.74
Magnesium oxide,	3.14	3.04	4.43	3.01
Ferric oxide,	1.05	1.24	1.24	0.37
Potassium oxide,	4.27	5.64	6.79	6.56
Phosphoric acid,	1.47	1.32	1.79	1.43
Insoluble matter (before calcination),	14.75	12.13	15.15	10.54
Insoluble matter (after calcination),	11.52	10.33	13.12	8.78

5. *Analyses, etc.* — Continued.

Wood Ashes.

[I. and II. sent on by C. F Clark, Granby, Mass.; III. sent on by L. B. Smith, Eastham, Mass.; IV. sent on by J. D. W. French, North Andover, Mass.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	15.37	13.17	14.08	14.52
Calcium oxide,	35.28	32.82	35.16	34.02
Magnesium oxide,	3.24	3.50	2.79	3.79
Ferric oxide,	1.62	2.80	0.93	0.94
Potassium oxide,	7.73	6.86	4.16	5.88
Phosphoric acid,	0.78	0.79	1.69	2.37
Insoluble matter (before calcination),	7.56	11.10	13.57	11.49
Insoluble matter (after calcination),	6.80	8.73	11.32	9.64

Wood Ashes.

[I. sent on by F. F. O'Neil, North Sudbury, Mass.; II. sent on by Jonathan Ames, South Lincoln, Mass.; III. sent on by F. C. Davis, East Longmeadow, Mass.; IV. sent on by B. W. Brown Concord, Mass.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	12.88	2.31	21.39	12.70
Calcium oxide,	35.41	32.82	28.01	32.67
Magnesium oxide,	2.75	5.34	2.86	2.64
Ferric oxide,	1.65	1.71	1.64	1.16
Potassium oxide,	6.17	6.53	4.60	5.22
Phosphoric acid,	1.83	2.29	2.21	1.40
Insoluble matter (before calcination),	12.69	20.46	13.66	24.81
Insoluble matter (after calcination),	11.60	16.20	12.37	17.41

5. *Analyses, etc.* — Continued.

Wood Ashes.

[I. sent on by Elijah Bradstreet, Danvers, Mass.; II. sent on by C. W. Copeland, Campello, Mass.; III. sent on by C. E. Adams, South Framingham, Mass.; IV. sent on by Thomas Roche, South Deerfield, Mass.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	12.33	10.24	11.01	23.36
Calcium oxide,	34.10	37.89	33.64	25.75
Magnesium oxide,	2.64	2.70	4.01	3.75
Ferric oxide,	0.98	0.85	1.30	–
Potassium oxide,	10.80	6.70	5.77	7.96
Phosphoric acid,	1.06	1.60	1.45	2.58
Insoluble matter (before calcination),	20.04	9.84	16.30	14.83
Insoluble matter (after calcination),	7.54	8.54	14.60	9.36

Cotton-hull Ashes.

[Sent on by W. L. Boutwell, Leverett, Mass.]

	Per Cent.
Moisture at 100° C.,	10.35
Calcium oxide,	19.35
Magnesium oxide,	10.99
Potassium oxide,	27.19
Phosphoric acid,	9.48
Insoluble matter (before calcination),	13.27
Insoluble matter (after calcination),	10.86

5. *Analyses, etc.* — Continued.

Saltpetre Waste.

[I. sent on from the American Powder Mills, Acton, Mass.; II. sent on by Coolidge Bros., South Sudbury, Mass.; III. sent on by L. B. Smith, Barre, Mass.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	5.19	0.38	4.82
Calcium oxide,	0.47	0.84	0.85
Magnesium oxide,	0.27	0.05	0.25
Sodium oxide,	36.82	49.37	50.07
Potassium oxide (4½ cents per pound),	15.04	2.55	1.55
Sulphuric acid,	1.02	0.81	1.30
Chlorine,	53.50	58.00	57.04
Nitrogen (17 cents per pound),	1.90	0.65	0.52
Insoluble matter,	Trace.	Trace.	0.09
Valuation per ton,	$20 00	$4 11	$3 17

Refuse from Glue Factory.

[Sent on by Chas. A. Newhall, Lynn, Mass.]

	Per Cent.
Moisture at 100° C.,	43.06
Organic and volatile matter,	71.02
Ash,	28.98
Phosphoric acid,	0.217
Nitrogen,	7.82
Insoluble matter,	18.65

5. *Analyses, etc.* — Continued.

Fish Chum.

[Two samples, sent on by L. B. Smith, Eastham, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	11.19	14.53
Organic and volatile matter,	84.94	44.35
Total phosphoric acid,	6.58	4.98
Soluble phosphoric acid,	0.44	0.57
Reverted phosphoric acid,	3.26	3.19
Insoluble phosphoric acid,	2.88	1.22
Nitrogen,	8.14	4.70
Insoluble matter,	1.23	29.37

Dry Ground Fish.

[I. sent on by S. S. Dwight, Hatfield, Mass.; II. sent on by S. G. Hubbard, Hatfield, Mass.; III. sent on by Thaddeus Graves, Hatfield, Mass.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	9.65	6.30	8.86
Ash,	22.40	20.40	17.72
Total phosphoric acid,	6.88	7.25	6.97
Soluble phosphoric acid,	0.49	0.52	0.49
Reverted phosphoric acid,	3.06	3.89	2.04
Insoluble phosphoric acid,	3.33	2.84	4.44
Nitrogen,	9.50	6.73	7.56
Insoluble matter,	1.92	4.99	1.17

5. *Analyses, etc.* — Continued.

Blood, Meat and Bone.

[Sent on by Isaac Madill, Lexington, Mass.]

	Per Cent.
Moisture at 100° C.,	7.87
Ash,	20.63
Calcium oxide,	10.33
Phosphoric acid,	8.29
Nitrogen,	5.84
Insoluble matter,	0.48

Ground Bone.

[I. sent on by E. H. Smith, Northborough, Mass.; II. sent on by the Hargrave Manufacturing Company, Fall River, Mass.; III. sent on by Anson Wheeler, Concord, Mass.; IV. sent on by A. W. Green, Carlton, Mass ; V. sent on by L. B. Smith, Eastham, Mass.]

Mechanical Analyses.

	Per Cent.				
	I.	II.	III.	IV.	V.
Fine, smaller than $\frac{1}{60}$ inch,	36.83	46.87	–	42.43	6.14
Fine medium, smaller than $\frac{1}{25}$ inch,	36.86	37.23	–	28.43	25.39
Medium, smaller than $\frac{1}{12}$ inch,	24.58	11.80	–	21.12	28.17
Coarser than $\frac{1}{12}$ inch,	1.73	4.10	–	8.02	40.30
	100.00	100.00	–	100.00	100.00

Chemical Analyses.

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	4.51	8.29	6.14	8.21	8.25
Ash,	56.83	67.21	50.71	62.02	57.53
Total phosphoric acid,	22.69	26.72	18.17	17.67	16.84
Soluble phosphoric acid,	0.14	0.34	4.14	0.56	0.14
Reverted phosphoric acid,	5.70	2.78	8.77	3.61	0.35
Insoluble phosphoric acid,	16.85	23.60	5.26	13.50	16.35
Nitrogen,	3.86	2.78	2.78	2.72	3.42
Insoluble matter,	1.48	0.65	1.02	0.36	1.29

5. *Analyses, etc.* — Continued.

Bones boiled in Potash.

[Sent on from South Framingham, Mass.]

	Per Cent.
Moisture at 100° C.,	10.96
Organic and volatile matter,	40.52
Total phosphoric acid,	20.85
Soluble phosphoric acid,	0.06
Reverted phosphoric acid,	11.25
Insoluble phosphoric acid,	9.54
Potassium oxide,	4.33
Nitrogen,	2.60
Insoluble matter,	0.12

Starch Waste.

[Sent on from Rubber Factory, Hudson, Mass.]

	Per Cent.
Moisture at 100° C.,	10.01
Ash,	0.23
Nitrogen,	0.026

"Sludge" from Worcester Sewage Precipitating Tanks.

[Sent on by J. G. Jefferds, Worcester, Mass.]

	Per Cent.	
	As Received.	Dried to 100° C.
Moisture at 100° C.,	88.49	–
Organic and volatile matter,	90.50	–
Calcium oxide,	1.58	16.69
Magnesium oxide,	0.39	4.13
Ferric and aluminic oxides,	6.22	65.36
Potassium oxide,	0.05	0.51
Phosphoric acid,	0.10	1.05
Nitrogen,	0.05	0.54
Insoluble,	0.93	9.76
Valuation per ton,	$0 35	$3 77

5. *Analyses, etc.* — Continued.

Tankage.

[Sent on by the Bowker Fertilizer Company, Boston, Mass.]

	Per Cent.
Moisture at 100° C.,	2.17
Total phosphoric acid,	12.79
Available phosphoric acid,	6.01
Insoluble phosphoric acid,	6.78
Fat (ether extract),	19.19

Florida Phosphate Rock.

[I., II. and III. sent on from Boston, Mass.; IV., V. and VI. sent on by Geo. Frost, Mandarin, Fla.; VII. sent on by M. D. Brooks, Fort Meade, Fla.]

Number.	Moisture at 100° C.	Phosphoric Acid.	Calcium Oxide.	Ferric and Aluminic Oxides.	Insoluble Matter.
I.,	1.43	33.33	44.16	1.31	4.65
II.,	1.18	27.07	37.57	2.59	21.96
III.,	5.47	6.95	12.36	4.07	53.61
IV.,	1.23	18.40	17.14	6.17	54.74
V.,	1.06	27.42	28.08	7.43	34.00
VI.,	10.79	2.92	0.55	–	71.32
VII.,	13.62	22.42	28.06	9.46	23.30

Phosphatic Fertilizers.

[I., plain superphosphate, sent on by Anson Wheeler, Concord, Mass.; II., dissolved bone-black, sent on by Anson Wheeler, Concord, Mass.; III., dissolved bone-black, sent on from Amherst, Mass.; IV., acid phosphate, sent on by L. B. Smith, Eastham, Mass.; V., German phosphatic slag, sent on from Amherst, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	10.43	10.26	20.07	10.39	0.47
Total phosphoric acid,	16.55	16.77	17.35	13.45	19.04
Soluble phosphoric acid,	10.87	13.92	14.80	10.17	–
Reverted phosphoric acid,	1.92	1.29	2.28	2.26	–
Insoluble phosphoric acid,	3.76	1.56	0.27	1.02	–
Calcium oxide,	Not determined.			–	46.47
Insoluble matter,	7.42	4.28	2.13	10.39	4.39

5. *Analyses, etc.* — Continued.

Hen Manure.

[Sent on by A. F. Hunter, South Natick, Mass.]

	Per Cent.
Moisture at 100° C.,	58.98
Ash,	24.75
Calcium oxide,	1.21
Magnesium oxide,	0.89
Potassium oxide,	0.32
Sulphuric acid (SO_3),	1.24
Phosphoric acid,	1.00
Nitrogen,	1.20
Insoluble matter,	17.69

Jute Waste.

[Sent on by J. H. Easterbrook, Dudley, Mass.]

	Per Cent.
Moisture at 100° C.,	13.10
Potassium oxide (4¼ cents per pound),	0.08
Phosphoric acid (6 cents per pound),	0.72
Nitrogen (10 cents per pound),	1.50
Valuation per ton,	$3 93

Shelled Corn, damaged by Fire and Water.

[Sent on by Chas. I. Pierce, West Northfield, Mass.]

	Per Cent.
Moisture at 100° C.,	21.40
Dry matter,	78.60
	100.00

Analysis of Dry Matter.

Crude ash,	1.54
" cellulose,	2.78
" fat,	4.96
" protein (nitrogenous matter),	9.77
Non-nitrogenous extract matter,	80.95
	100.00

Fertilizing Constituents of the Above.

	Per Cent.
Moisture at 100° C.,	21.40
Ash,	1.21
Phosphoric acid,	0.48
Potassium oxide,	0.28
Nitrogen,	1.06
Insoluble matter,	0.10
Valuation per ton,	$1 52

5. *Analyses, etc.* — Continued.

Buckwheat Hulls.

[Sent on by E. L. Smith, South Schodack, N. Y.]

	Per Cent.
Moisture at 100° C,	11.900
Calcium oxide,	0.247
Magnesium oxide,	0.236
Ferric oxide,	0.020
Potassium oxide,	0.521
Phosphoric acid,	0.073
Nitrogen,	0.490
Insoluble matter,	0.066

Sea Weed.

[Sent on by D. C. Potter, Fairhaven, Mass.]

	Per Cent.
Moisture at 100° C.,	16.260
Calcium oxide,	2.061
Magnesium oxide,	1.175
Sodium oxide,	3.529
Potassium oxide,	0.785
Phosphoric acid,	0.191
Nitrogen,	4.250
Insoluble matter,	5.525

Residuum from Soft Coal.

[Sent on by B. N. Farren, Montague City, Mass.]

	Per Cent.
Moisture at 100° C.,	2.63
Calcium oxide,	1.38
Magnesium oxide,	0.45
Ferric oxide,	6.02
Aluminic oxide,	2.71
Potassium oxide,	0.20
Phosphoric acid,	0.47
Insoluble matter (before calcination),	88.09
Insoluble matter (after calcination),	72.38

5. *Analyses, etc.* — Continued.

"*Vegetable Ivory.*"

[Sent on by Moses Field, Longmeadow, Mass.]

	Per Cent.
Moisture at 100° C.,	8.140
Organic and volatile matter,	93.580
Ash,	6.420
Calcium oxide,	4.842
Magnesium oxide,	0.430
Ferric oxide,	0.043
Sodium oxide,	0.125
Potassium oxide,	0.461
Phosphoric acid,	0.237
Nitrogen,	0.500
Silicic acid,	0.033
Insoluble matter,	0.196

Concentrated Flower Food.

[Sent on from Springfield, Mass.]

	Per Cent.
Moisture at 100° C.,	11.20
Ash,	42.89
Phosphoric acid,	5.30
Lime,	6.18
Sulphuric acid,	15.73
Potassium oxide,	4.72
Sodium oxide,	17.45
Nitrogen in organic matter,	2.31
Nitrogen in nitrates,	4.66
Insoluble matter,	0.25

"*Flora Vita.*"

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C,	85.30
Solids,	14.70
Ferric and aluminic oxides,	0.65
Calcium oxide,	0.72
Magnesium oxide,	0.17
Potassium oxide,	4.16
Sodium oxide,	2.48
Phosphoric acid,	2.80
Sulphuric acid,	0.84
Chlorine,	0.06
Nitrogen,	2.61

5. *Analyses, etc.* — Concluded.

Compound Fertilizers.

[I. sent on by C. A. Bartlett, Worcester, Mass ; II. sent on by Ebed L. Ripley, Hingham, Mass.; III. sent on by A. L. Ames, Peabody, Mass.; IV. and V. sent on by A. E. Belden, North Hadley, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	3.54	4.41	10.70	14.29	9.26
Ash,	37.69	34.28	–	56.28	50.07
Total phosphoric acid,	14.12	14.70	10.55	12.04	7.39
Soluble phosphoric acid,	1.41	0.58	5.69	7.27	5.27
Reverted phosphoric acid,	7.46	6.84	3.66	3.41	0.24
Insoluble phosphoric acid,	5.25	7.28	1.20	1.36	1.88
Potassium oxide,	0.07	0.46	0.96	4.39	7.30
Nitrogen,	4.84	6.18	3.77	4.58	5.10
Insoluble matter,	0.55	0.49	1.29	0.72	0.82

Compound Fertilizers.

[I. sent on by J. M. Butman, Lowell, Mass.; II. sent on by Joseph Breck & Sons, Boston, Mass.; III. sent on by A. F. Crocker, North Amherst, Mass.; IV. and V. sent on by L. B. Smith, Eastham, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	8.99	11.01	9.16	11.51	15.81
Ash,	51.46	71.33	61.27	84.53	72.59
Total phosphoric acid,	14.57	8.47	14.89	0.67	10.23
Soluble phosphoric acid,	6.54	2.64	5.38	–	4.54
Reverted phosphoric acid,	5.83	4.38	3.78	0.50	4.32
Insoluble phosphoric acid,	2.20	1.45	5.73	0.17	1.37
Potassium oxide,	2.26	3.81	3.24	9.67	3.71
Nitrogen,	3.07	3.88	2.30	4.30	1.84
Insoluble matter,	0.83	4.31	4.90	1.74	7.41

Methods of Fertilizer Analysis.

Preparation of Sample. — The entire available sample is spread upon a smooth, hard surface, and intimately mixed without grinding, all lumps being broken up with a spatula. Unnecessary loss or gain of moisture is to be avoided. *Moisture:* dry 2 grams in the air-bath at 100 to 110° C. to a constant weight.

1. Total Phosphoric Acid. — Weigh out 2 grams in a platinum crucible, and destroy the organic matter by carefully burning in a muffle. Weigh when cool, to determine the "organic and volatile matter." Digest the crucible and contents with dilute hydrochloric acid, until the solution of the latter is complete. Filter, and evaporate the filtrate to complete dryness. The "insoluble matter" on the filter is burned and weighed. The residue left from the evaporation is taken up with dilute nitric acid, if the molybdic method is to be followed, but with hydrochloric acid if method (2) is preferred. The solution after filtering is made up to a volume of 200 cubic centimetres with distilled water.

(1) The molybdic method: 25 cubic centimetres of the solution are digested in a water-bath at 65° C. from one to two hours, with an excess of molybdic solution. The precipitate is brought upon a filter, and washed with water containing a little molybdic solution. It is then dissolved in ammonia water, the solution nearly neutralized with hydrochloric acid, and magnesia mixture added slowly, with constant stirring. The precipitate is allowed to stand at least three hours, when it is filtered through a Gooch crucible, washed with dilute ammonia, ignited and weighed.

(2) The following method is occasionally employed when phosphates of iron and alumina are present in small quantities only: To 50 cubic centimetres of the hydrochloric acid solution add ammonia in slight excess. After standing a few minutes, acidify with acetic acid, and filter off the phosphates of iron and alumina, washing carefully with water. To the filtrate add sufficient oxalate of ammonia to precipitate all the lime; digest for several hours at a temperature below boiling, and filter through double filters which have

previously been washed with oxalate of ammonia, washing thoroughly with water. Dissolve the phosphates of iron and alumina on the filter with warm dilute hydrochloric acid, and wash into a beaker containing a small quantity of powdered tartaric acid. When the latter has gone into solution, mix with the filtrate from the oxalate of ammonia. The phosphoric acid is precipitated with magnesia mixture, and treated as in (1).

Soluble phosphoric acid: Weigh out 2 grams into a beaker, cover with 10 to 15 cubic centimetres of water, and allow it to stand for fifteen minutes, stirring three times at equal intervals. Decant the solution through a filter into a graduated cylinder. Add another like quantity of water, and let it stand fifteen minutes more, stirring as before. Filter the solution into the cylinder, and wash the residue on the filter until the filtrate amounts to 200 cubic centimetres. The phosphoric acid is determined in an aliquot part of the solution as under total phosphoric acid.

Insoluble phosphoric acid: Add 100 cubic centimetres of neutral ammonia citrate (sp. gr. 1.09) to the beaker in which the digestion with water has been made. Put in a water-bath and heat to 65° C. Drop in the filter containing the residue from the above operation, and digest for thirty minutes, stirring every five minutes. Filter and wash thoroughly, using the suction pump. Dry, and burn. The ash is then treated as under total phosphoric acid.

Reverted phosphoric acid: The sum of the soluble and insoluble subtracted from the total gives the reverted or citrate-soluble phosphoric acid.

Reagents: The reagents used in the estimation of phosphoric acid are prepared according to directions given in the "Proceedings of the Association of Official Agricultural Chemists," 1889, pages 225 and 226.

For ammonium citrate, 370 grams of citric acid are dissolved in 1,500 cubic centimetres of water, nearly neutralized with crushed carbonate of ammonia, heated to expel carbonic acid, exactly neutralized with ammonia, and brought to a specific gravity of 1.09.

The molybdic solution is prepared by dissolving 100 grams of molybdic acid in 417 cubic centimetres of ammonia of

specific gravity .96. Pour this solution into 1,250 cubic centimetres of nitric acid of specific gravity 1.20, and set in a warm place for several days, or until a portion heated to 40° C. deposits no yellow precipitate.

The magnesia mixture is prepared by dissolving 110 grams of crystallized magnesium chloride and 280 grams of ammonium chloride in 700 cubic centimetres of ammonia of specific gravity .96, and bringing to a volume of two liters.

2. Methods of Determining Nitrogen. — The Kjeldahl and soda-lime methods recommended by the Association of Official Agricultural Chemists, in their "Proceedings," 1889, pages 218 to 221, are employed, with occasional control analyses by the absolute cupric oxide mode.

3. Method for Determining Potash. — Weigh out two grams of the material in a platinum crucible, and char thoroughly at a temperature just below red heat. Digest for several hours with very dilute hydrochloric acid, on the water-bath. Filter into a graduated cylinder, and make up to 200 cubic centimetres. Take 50 cubic centimetres for each test. Warm, and add, in small quantities at a time, an excess of barium hydrate. Digest for one or two hours at a temperature of 70 to 90° C., filter, washing carefully, and add to the filtrate a few drops of ammonium hydrate, and enough ammonium carbonate to precipitate the excess of barium hydrate. Filter, and bring the filtrate to dryness on the water-bath in a platinum dish. Heat carefully in the covered platinum dish at a temperature just below red heat, until compounds of ammonia cease to come off. Take up the residue in water, filtering if necessary, and add an excess of platinum tetrachloride. Evaporate to dryness on the water-bath, add a small quantity of 80 per cent. alcohol, and allow it to stand for a few hours. Filter through a Gooch crucible, washing with alcohol, dry, and weigh; or filter through paper, wash as before, dry, and brush the potassium platinic chloride upon a weighed watch glass, with a camel's-hair brush, and weigh. If very impure, the double salt is washed with the strong solution of ammonium chloride, saturated with potassium platinic chloride, as recommended in the "Proceedings of the Association of Official Agricultural Chemists," 1889, page 223.

6. *Miscellaneous Analyses.*
(*Insecticides*).

Paris Green.

[Sent on from Amherst, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	1.34	1.31
Copper oxide,	33.35	33.45
Arsenious oxide,	61.25	61.21
Insoluble matter,	0.13	0.09
Acetic acid,	3.93	3.94
	100.00	100.00

Sulphatine.

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	1.40
Calcium oxide,	18.60
Copper oxide,	2.61
Sulphuric acid,	4.73
Sulphur,	48.28
Insoluble matter,	1.63

Death to Rose Bugs.

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	2.95
Ash,	54.14
Calcium oxide,	17.76
Copper oxide,	1.05
Sulphuric acid,	4.35
Sulphur,	34.53
Insoluble matter,	0.49

6. *Miscellaneous Analyses* — Concluded.

Prof. De Graff's Bug Destroyer.

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	95.811
Residue from evaporation,	4.189
Mercury,	0.782
Chlorine,	0.265
Sulphuric acid,	0.484
Aluminic oxide,	0.904
Potassium oxide,	0.267

Tobacco Liquor.

[I. sent on by Franklin Crocker, Hyannis, Mass.; II. made at station: 6 pounds of stems treated for two days with warm water gave 13.5 ounces liquor.]

	Per Cent.	
	I.	II.
Specific gravity,	1.3858	1.3777
Moisture at 100° C.,	37.710	40.890
Ash,	19.420	27.770
Nitrogen, total,	2.010	1.730
Nitrogen as nitrates,	0.170	–
Nicotine,	2.115	0.530
Ferric and aluminic oxides,	0.229	0.017
Calcium oxide,	3.069	1.466
Magnesium oxide,	2.303	1.121
Phosphoric acid,	0.404	0.057
Sodium oxide,	0.207	0.525
Potassium oxide,	6.550	16.340
Insoluble matter,	Trace.	–

II. Analyses of Water sent on for Examination.

[Parts per million.]

Number.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Solids at 100° C.	Solids at Red Heat.	Hardness (Clark's Degree).	Lead.	Locality.
1,	.06	.120	3.00	32.00	24.00	1.95	–	Amherst.
2,	.02	.140	6.00	90.00	58.00	2.60	None.	Amherst.
3,	.02	.040	Trace.	44.00	20.00	.79	None.	Rutland.
4,	None.	.03	52.00	194.00	70.00	3.51	None.	North Hadley.
5,	.02	.03	14.00	170.00	90.00	8 14	None.	Southbridge.
6,	.016	.070	32.00	224.00	84.00	2.60	None.	Amherst.
7,	.60	.12	10.00	58.00	16.00	1.69	None.	Gilbertville.
8,	.02	.04	16.00	162.00	76.00	3.25	None.	Northborough.
9,	.02	.03	8.00	96.00	16.00	1.27	None.	Amherst.
10,	.20	.04	12.00	92.00	48.00	1.95	None.	Gilbertville.
11,	.18	.04	12.00	74.00	40.00	1.95	None.	Gilbertville.
12,	.08	.12	24.00	130.00	62.00	3.51	–	Foxborough.
13,	Trace.	.04	16.00	102.00	46.00	3.25	None.	Southbridge.
14,	.20	.18	32.00	378.00	150.00	–	–	Amherst.
15,	.01	.07	Trace.	82.00	14.00	.79	–	Westhampton.
16,	.03	.14	Trace.	60.00	8.00	.63	None.	West Farms.
17,	.16	.06	20.00	160.00	30.00	2.99	–	North Amherst.
18,	.16	.32	6.00	134.00	36.00	1.27	–	South Gardner.
19,	.25	.30	4.00	–	–	–	–	Amherst.
20,	.08	.06	10.00	320.00	210.00	11.35	–	Rome, N. Y.
21,	None.	.08	16.00	168.00	28.00	2.60	–	North Amherst.
22,	.04	.20	18.00	178.00	98.00	3.77	None.	Amherst.
23,	Trace.	.04	14.00	102 00	92.00	1.56	Present.	Amherst.
24,	.02	.48	6.00	110.00	10.00	2.99	–	Northborough.
25,	.06	.10	22.00	274 00	104.00	6.71	None.	South Deerfield.
26,	Trace.	.04	10.00	160.00	40.00	2.86	–	Amherst.
27,	.13	.12	8.00	144.00	44.00	1.43	None.	Ashby.
28,	.03	.04	8.00	124.00	24.00	4.16	None.	Sunderland.
29,	Trace.	.02	28.00	144.00	14.00	5.00	Present.	Amherst.

Analyses of Water — Continued.

Number.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Solids at 100° C.	Solids at Red Heat.	Hardness (Clark's Degree).	Lead.	Locality.
30,	None.	.05	20.00	180.00	60.00	3.38	None.	Roxbury.
31,	Trace.	.24	10.00	210.00	60.00	4.71	–	Sunderland.
32,	.24	15.36	12.00	64.00	20.00	1.95	–	Sunderland.
33,	.04	.20	8.00	110.00	14.00	2.08	–	Amherst.
34,	None.	.04	12.00	170.00	70.00	3.77	None.	Amherst.
35,	.01	.05	6.00	152.00	30.00	8.14	None.	South Amherst.
36,	.72	.56	6.00	154.00	76.00	3.51	–	Littleton.
37,	None.	.036	6.00	62.00	40.00	2.08	Present.	Amherst.
38,	.01	.135	34.00	202.00	100.00	2.73	–	Eastham.
39,	.06	.628	10.00	124.00	98.00	3.25	–	Amherst.
40,	1.12	3.84	28.00	450.00	216.00	6.86	None.	Amherst.
41,	.04	.104	14.00	180.00	54.00	3.25	None.	Amherst.
42,	.072	.10	8.00	126.00	90.00	3.25	None.	Sunderland.
43,	.276	.172	4.00	60.00	38.00	2.60	–	North Amherst.
44,	.128	.196	16.00	150.00	74.00	1.69	None.	Westford.
45,	.104	.152	4.00	34.00	16.00	.32	Present.	Westford.
46,	.10	.112	68.00	392.00	122.00	5.71	None.	Westford.
47,	.084	.128	16.00	150.00	44.00	1.69	None.	Westford.
48,	.08	.196	70.00	420.00	164.00	6.00	None.	Acton.
49,	.068	.120	22.00	124.00	54.00	1.27	–	Gloucester.
50,	.37	.21	12.00	58.00	28.00	1.95	None.	Weston.
51,	.022	.068	20.00	204.00	120.00	3.90	None.	Amherst.
52,	1.55	.40	32.00	314.00	118.00	3.90	Present.	Amherst.
53,	.064	.176	60.00	352.00	158.00	3.51	Present.	Amherst.
54,	.140	.180	76.00	458.00	150.00	9.57	Present.	Acton.
55,	.088	.080	12.00	92.00	78.00	1.95	None.	Barre Plains.
56,	.060	.044	16.00	156.00	56.00	2.60	None.	Barre Plains.
57,	.084	.092	Trace.	62.00	44.00	.48	None.	Brookline.
58,	.076	.108	4.00	32.00	20.00	.32	None.	Brookline.
59,	.100	.248	36.00	110.00	10.00	1.95	None.	Brookline.

Analyses of Water — Concluded.

Number.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Solids at 100° C.	Solids at Red Heat.	Hardness (Clark's Degree).	Lead.	Locality.
60,	.08	.226	14.00	106.00	40.00	2.47	None.	Leverett.
61,	Trace.	.016	Trace.	88.00	18.00	3.25	None.	Shutesbury.
62,	.052	.052	340.00	844.00	664.00	3.25	None.	Clifton.
63,	.188	.176	8.00	126.00	82.00	2.60	Present.	Bedford.
64,	.140	.180	32.00	560.00	460.00	6.71	None.	Bedford.
65,	.088	.116	24.00	320.00	220.00	3.64	None.	Bedford.

The analyses have been made according to Wancklyn's process, familiar to chemists, and are directed towards the indication of the presence of chlorine, free and albuminoid ammonia, and the poisonous metals, lead in particular. (For a more detailed description of this method, see "Water Analyses," by J. A. Wancklyn and E. T. Chapman.)

Mr. Wancklyn's interpretation of the results of his mode of investigation is as follows: —

1. Chlorine alone does not necessarily indicate the presence of filthy water.

2. Free and albuminoid ammonia in water, without chlorine, indicates a vegetable source of contamination.

3. More than five grains per gallon* of chlorine (=71.4 parts per million), accompanied by more than .08 parts per million of free ammonia and more than .10 parts per million of albuminoid ammonia, is a clear indication that the water is contaminated with sewage, decaying animal matter, urine, etc., and should be condemned.

4. Eight-hundredths parts per million of free ammonia and one-tenth part per million of albuminoid ammonia render a water very suspicious, even without much chlorine.

* One gallon equals 70,000 grains.

5. Albuminoid ammonia, over .15 parts per million, ought to absolutely condemn a water which contains it.

6. The total solids found in the water should not exceed forty grains per gallon (571.4 parts per million).

An examination of the previously stated results of analyses indicate that Nos. 7, 10, 11, 14, 17, 18, 19, 23, 27, 29, 32, 36, 37, 40, 43, 44, 45, 46, 50, 52, 54, 59, 63 and 64 ought to be condemned as unfit for family use, while Nos. 12, 20, 25, 33, 39, 42, 47, 48, 49, 53, 55, 56, 58, 60 and 65 must be considered suspicious. From this record it will be seen that over one-third of the entire number of well waters tried proved unfit for drinking. Heating well waters to the boiling point removes, not unfrequently, immediate danger. Eight samples gave unmistakable evidence of the presence of lead.

Parties sending on water for analysis ought to be very careful to use clean vessels, clean stoppers, etc. The samples should be sent on without delay after collecting. One gallon is desirable for the analysis.

Compilation of Analyses made at Amherst, Mass., of Agricultural Chemicals and Refuse Materials used for Fertilizing Purposes.

Prepared by W. H. Beal.

[As the basis of valuation changes from year to year, no valuation is stated.]

1868-1891.

This compilation does not include the analyses made of licensed fertilizers. They are to be found in the reports of the State Inspector of Fertilizers from 1873 to 1890, contained in the reports of the Secretary of the Massachusetts State Board of Agriculture for those years. C. A. G.

	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.			Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.								
I. Chemicals, Refuse Salts, Ashes, etc.																						
Muriate of potash,	54	2.00	–	–	–	–	58.98	45.94	51.80	–	–	–	–	–	–	6.69	–	.55	–	–	–	.75
Sulphate of potash,	19	2.50	–	–	–	–	51.28	21.36	33.60	–	–	–	–	–	–	4.46	–	1.50	–	45.72	–	.75
Sulphate of potash and magnesia,	15	4.75	–	–	–	–	29.48	16.96	23.50	–	–	–	–	–	–	6.25	2.57	–	–	44.25	–	1.41
Kainite,	4	3.20	–	–	–	–	16.48	12.61	13.54	–	–	–	–	–	–	18.97	1.15	9.80	–	20.55	–	2.13
Carnallite,	1	–	–	–	–	–	–	–	13.68	–	–	–	–	–	–	7.66	–	13.19	–	.56	–	–
Krugite,	1	4.82	–	–	–	–	–	–	8.42	–	–	–	–	–	–	5.57	12.45	8.79	–	31.94	–	14.96
Sulphate of magnesia (*Kieserite*),	9	22.20	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.82	17.30	–	36.10	–	5.73
Nitrate of potash,	2	1.93	–	14.58	11.60	13.09	45.62	44.76	45.19	–	–	–	–	–	–	–	–	–	–	–	–	–
Nitrate of soda,	19	1.40	–	16.01	14.44	15.75	–	–	–	–	–	–	–	–	–	35.25	–	–	–	–	–	.50
Sulphate of ammonia,	24	1.00	–	21.68	19.70	20.50	–	–	–	–	–	–	–	–	–	–	–	–	–	60.00	–	–
Saltpetre waste,	10	2.75	–	3.30	.52	2.43	30.94	1.55	15.50	–	–	–	–	–	–	34.25	.75	.19	–	1.85	–	48.30
Nitre salt-cake,	2	6.03	–	–	–	2.29	–	–	.87	–	–	–	–	–	–	29.56	–	–	–	47.77	–	3.92
Wood ashes,	156	12.00	–	–	–	–	10.89	2.93	5.25	4.61	.51	1.75	–	–	–	–	34.80	3.25	.88	–	–	12.50
Cotton-seed hull ashes,	21	7.33	–	–	–	–	42.12	17.31	23.80	13.67	2.89	8.50	–	–	–	–	9.50	11.25	1.60	–	–	11.79
Ashes of spent tan-bark,	3	3.61	–	–	–	–	2.87	1.14	2.04	2.77	.18	1.61	–	–	–	–	33.46	3.55	–	–	–	24.33

Logwood ashes,	1	1.50	–	–	–	–	–	–	.08	–	–	2.30	–	–	–	–	3.90	–	–	–	–	–	9.70
Hard-pine wood ashes,	1	.75	–	–	–	–	–	–	10.16	–	–	2.24	–	–	–	–	24.95	–	–	–	–	–	29.90
Mill ashes,	1	.53	–	–	–	–	–	–	1.60	–	–	.46	–	–	–	–	34.93	1.35	–	–	–	–	36.36
Ashes from blue works,	1	12.74	63.78	–	–	–	–	–	9.02	–	–	–	–	–	–	–	–	–	–	–	–	–	12.30
Sea-weed ashes,	1	1.47	–	–	–	–	–	–	.92	–	–	.30	–	–	–	8.76	6.06	4.37	–	2.98	–	6.60	63.65
Nova Scotia plaster,	10	6.50	–	–	–	–	–	–	–	–	–	–	–	–	–	–	33.85	.75	–	45.75	–	–	2.50
Onondaga plaster,	4	13.27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30.00	4.66	–	32.50	8.20	–	9.83
Gas-house lime,	3	22.28	–	–	–	–	–	–	–	–	–	–	–	–	–	–	43.66	8.30	–	20.73	–	–	6.05
Lime waste from sugar factory,	1	36.30	–	–	–	–	–	–	.22	–	–	2.25	–	–	–	–	27.51	–	–	–	–	–	.32
Lime-kiln ashes,	7	15.45	–	–	–	–	1.70	.02	.86	3.16	.36	1.18	–	–	–	–	44.80	2.60	–	–	17.75	–	8.25
Marls (Massachusetts),	5	18.18	–	–	–	–	–	–	–	2.72	.06	1.05	–	–	–	–	40.07	.64	.69	–	28.51	–	3.44
Marls (Virginia),	2	15.98	–	–	–	–	.61	.37	.49	.09	.08	.09	–	–	–	–	7.25	.21	–	.66	7.25	–	64.23
Marl (North Carolina),	1	1.50	–	–	–	–	–	–	.04	–	–	.56	–	–	–	–	21.95	.61	–	–	–	–	50.18
II. Guanos, Phosphates, etc.																								
Peruvian guano,	26	14.81	37.61	13.50	4.44	7.85	4.08	1.14	2.61	20.60	5.96	15.26	4.57	3.79	6.90	–	–	–	–	–	–	–	6.60
Bat guano from Texas,	9	40.09	18.24	10.51	2.58	6.47	–	–	1.31	6.53	1.00	3.76	–	–	–	–	–	–	–	–	–	–	2.00
Cuba guano,	5	24.27	.67	2.74	.63	1.67	–	–	–	16.16	11.54	13.35	–	–	–	–	–	–	–	–	–	–	3.17
Caribbean guano (*Orchilla*),	12	7.31	–	–	–	–	–	–	–	35.43	18.11	26.77	–	–	–	–	39.95	3.29	–	2.08	–	–	1.27
Mona Island guano,	1	13.32	–	–	–	.76	–	–	–	–	–	21.88	–	7.55	14.33	–	37.49	–	–	–	–	–	2.45
South Carolina rock phosphate,	5	1.50	–	–	–	–	–	–	–	30.51	25.81	28.03	.27	.33	27.69	–	41.87	3.03	4.80	–	–	–	9.04
Florida rock phosphate,	14	2.12	–	–	–	–	–	–	–	37.27	6.95	22.19	–	–	–	–	23.31	–	6.03	–	–	–	34.14

	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
II. Guanos, Phosphates, etc.—Concluded.																							
Navassa phosphate,	2	7.60	–	–	–	–	–	–	–	34.45	34.09	34.27	–	–	–	–	37.45	–	10.27	–	–	–	2.70
Brockville phosphate,	1	2.50	–	–	–	–	–	–	–	–	–	35.21	–	–	–	–	–	–	–	–	–	–	6.46
Phosphatic slag,	4	1.45	–	–	–	–	–	–	–	30.51	18.91	23.43	–	3.06	21.65	–	48.66	3.42	10.12	–	–	–	9.40
Bone-black,	5	4.60	–	–	–	–	–	–	–	30.54	16.56	28.26	–	–	–	–	–	–	–	–	–	–	3.64
South American bone-ash,	1	7.00	–	–	–	–	–	–	–	–	–	35.69	–	–	–	–	44.89	–	–	–	–	–	4.50
III. Refuse Substances.																							
Dried blood,	14	12.50	6.37	13.55	8.10	10.52	–	–	–	6.23	1.53	1.91	–	–	–	–	–	–	–	–	–	–	–
Ammonite,	1	5.88	–	–	–	11.33	–	–	–	–	–	3.43	–	–	–	–	–	–	–	–	–	–	1.38
Oleomargarine refuse,	1	8.54	14.42	–	–	12.12	–	–	–	–	–	.88	–	–	–	–	–	–	–	–	–	–	.96
Felt refuse,	1	29.24	33.53	–	–	5.26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8.44
Sponge refuse,	1	7.25	–	–	–	2.43	–	–	–	–	–	3.19	–	–	–	–	3.94	1.27	–	–	–	–	39.05
Horn and hoof waste,	3	10.17	7.63	15.49	11.84	13.25	–	–	–	2.30	1.36	1.83	–	–	–	–	–	–	–	–	–	–	.24
Raw wool,	1	6.95	7.54	–	–	12.88	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3.63
Wool waste,	5	9.27	–	10.20	1.18	5.64	3.08	.54	1.30	–	–	.29	–	–	–	–	.67	.07	–	–	–	–	4.60
Wool washings (water),	1	–	–	–	–	–	–	–	3.92	–	–	–	–	–	–	.49	.28	–	–	–	–	–	–

Wool washings (acid),	1	–	–	–	–	–	–	–	4.20	–	–	–	–	–	–	.40	.61	.20	–	–	–	–	–
Wool washings (alkaline),	1	92.03	3.28	–	–	.09	–	–	1.09	–	–	–	–	–	–	.92	.04	–	–	–	–	–	.22
Meat mass,	5	12.09	18.60	11.50	9.69	10.44	–	–	–	3.58	.56	2.07	–	–	–	–	–	–	–	–	–	–	.58
Bone soup,	1	82.92	7.07	–	–	1.14	–	–	–	–	–	1.26	–	–	–	–	–	–	–	–	–	–	–
Dried soup from meat and bone,	1	14.80	8.40	–	–	9.97	–	–	–	–	–	.53	–	–	–	–	–	–	–	–	–	–	.64
Dried soup from rendering cattle feet,	1	10.80	7.50	–	–	14.47	–	–	–	–	–	.46	–	–	–	–	–	–	–	–	–	–	.26
Dried soup from horse rendering,	1	92.14	–	–	–	1.12	–	–	–	–	–	.14	–	–	–	–	–	–	–	–	–	–	–
Soap-grease refuse,	2	29.25	51.39	4.20	2.21	3.21	–	–	–	15.37	11.04	13.21	–	–	–	–	–	–	–	–	–	–	1.29
Bones,	131	7.47	56.07	4.70	1.62	4.12	–	–	–	32.52	18.04	23.50	.43	7.85	15.22	–	–	–	–	–	–	–	1.25
Tankage,	18	13.20	28.75	8.07	4.60	6.82	–	–	–	16.94	8.76	11.25	.27	4.75	6.23	–	–	–	–	–	–	–	1.23
Fish with less than twenty per cent. water,	55	12.75	21.50	11.40	6.81	7.25	–	–	–	11.26	5.50	8.25	.55	2.50	5.10	–	–	–	–	–	–	–	2.20
Fish with between twenty and forty per cent. water,	9	29.34	19.14	7.41	4.22	5.81	–	–	–	8.32	4.68	7.25	.82	2.87	3.56	–	–	–	–	–	–	–	1.85
Fish with more than forty per cent. water,	10	45.46	15.50	7.60	2.43	4.97	–	–	–	8.56	2.94	5.08	1.17	1.33	2.58	–	–	–	–	–	–	–	1.35
Whale meat, raw,	1	44.50	1.04	–	–	4.86	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lobster shells,	1	7.27	–	–	–	4.50	–	–	–	–	–	3.52	–	–	–	–	22.24	1.30	–	–	–	–	.27
Castor-bean pomace,	4	9.98	5.70	5.72	5.33	5.56	1.70	.64	1.12	2.22	1.57	2.16	–	–	–	–	.87	.29	–	–	–	–	1.75
Cotton-seed meal,	10	7.75	5.77	7.26	4.02	6.66	2.09	.89	1.62	3.17	1.26	1.95	–	–	–	–	.39	.99	–	–	–	–	.60
Rotten brewer's grain,	1	78.77	–	–	–	.72	–	–	.04	–	–	.43	–	–	–	–	.26	.15	–	–	–	–	.59
Tobacco stems,	6	10.61	14.07	2.91	.90	2.29	8.82	3.76	6.44	2.09	.44	.60	–	–	–	.34	3.89	1.23	–	–	–	–	.82
Cotton waste, wet,	1	34.69	–	–	–	1.30	–	–	.80	–	–	1.54	–	–	–	–	2.45	1.13	–	–	–	–	41.33
Cotton waste, dry,	2	6.89	–	2.09	1.32	1.71	1.62	.89	1.26	.84	.83	.84	–	–	–	–	1.99	.77	–	–	–	–	34.89

	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
III. Refuse Substances — Concluded.																							
Cotton dust,	1	34.46	50.93	–	–	.50	–	–	.19	–	–	.21	–	–	–	–	.90	.90	–	–	–	–	47.46
Glucose refuse,	1	8.10	–	–	–	2.62	–	–	.15	–	–	.29	–	–	–	–	.18	.02	–	–	–	–	.07
Hop refuse,	1	8.98	–	–	–	.98	–	–	.11	–	–	.20	–	–	–	–	.27	.10	–	–	–	–	.63
Sumac waste,	1	63.06	6.80	–	–	1.19	–	–	3.25	–	–	–	–	–	–	–	1.14	3.25	–	–	–	–	2.25
Eel-grass,	2	35.39	15.60	.96	.70	.83	1.61	.21	.91	.41	.22	.32	–	–	–	1.63	2.13	.11	–	–	–	–	1.06
Rockweed, green,	1	68.50	23.70	–	–	.62	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Rockweed, dry,	1	10.63	35.75	–	–	1.45	–	–	4.89	–	–	2.75	–	–	–	7.90	7.66	.21	–	–	–	–	10.40
Wet kelp,	1	88.04	2.26	–	–	.26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Blue-green alga (*Lyngbia majuscula*), dry,	1	16.26	–	–	–	4.25	–	–	.79	–	–	.19	–	–	–	3.53	2.06	1.18	–	–	–	–	5.53
Mussel mud, wet,	1	60.01	27.29	–	–	.21	–	–	6.17	–	–	.10	–	–	–	.70	.93	.14	3.48	–	–	–	–
Mussel mud, dry,	1	2.24	72.02	–	–	.72	–	–	–	–	–	.35	–	–	–	–	23.39	–	8.26	–	–	–	37.60
Salt mud,	2	53.37	41.19	.40	.39	.40	.33	.32	.33	–	–	–	–	–	–	.04	.91	.37	4.13	–	–	–	34.88
Fresh-water mud,	1	40.37	–	–	–	1.37	–	–	.22	–	–	.26	–	–	–	–	1.27	.29	1.80	–	–	–	18.26
Muck,	12	55.13	13.75	2.54	.26	1.12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Peat,	9	61.60	7.71	1.40	.41	.75	–	–	–	–	–	–	–	–	–	–	.50	–	–	–	–	–	.38

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COMPILATION OF ANALYSES OF FODDER ARTICLES, FRUITS, SUGAR-PRODUCING PLANTS, DAIRY PRODUCTS, ETC.,

MADE AT

AMHERST, MASS.

1868-1891.

PREPARED BY W. H. BEAL.

A. ANALYSES OF FODDER ARTICLES.

B. ANALYSES OF FODDER ARTICLES WITH REFERENCE TO FERTILIZING INGREDIENTS.

C. ANALYSES OF FRUIT.

D. ANALYSES OF SUGAR-PRODUCING PLANTS.

E. DAIRY PRODUCTS.

A. *Analyses of Fodder Articles.*

NAME.	Analyses.	Dry Matter.			One Hundred Parts of Dry Matter contain —													Ash.	Nutritive Ratio (Average).
					Protein.			Fat.			Nitrogen — free extract.			Fibre.					
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.			
I. Green Fodders.																			
Fodder corn,	23	30.53	10.33	19.13	17.19	8.04	10.33	6.10	1.42	2.42	63.13	42.02	55.30	31.53	19.26	25.97	5.98	1:7.99	
Fodder corn (ensilaged),	26	28.59	13.12	22.03	12.58	5.98	8.11	6.49	1.82	3.84	65.69	42.99	55.79	38.92	17.67	26.88	5.38	1:10.80	
Sorghum,	6	23.18	12.38	17.41	11.84	7.46	8.74	2.00	1.21	1.55	64.93	47.65	56.15	29.27	22.00	26.73	6.83	1:11.62	
Common millet,	9	49.29	21.32	35.42	12.16	5.43	7.50	3.99	2.09	2.74	58.61	46.39	53.89	33.98	24.88	30.99	4.84	-	
Japanese millet ("white head"),	3	26.24	20.95	24.76	10.98	7.26	8.72	2.64	1.94	2.33	50.87	46.71	49.60	38.90	30.12	34.47	4.88	-	
Japanese millet ("red head"),	6	33.83	22.66	27.33	7.99	4.92	6.90	2.45	1.58	2.01	60.83	50.11	52.91	35.29	25.21	32.10	6.08	-	
White kibi,	2	24.26	22.85	23.56	15.14	10.79	12.97	1.61	1.50	1.56	53.66	52.30	52.91	31.70	23.03	27.37	5.19	-	
Mochi millet,	3	42.29	30.07	37.42	11.90	6.11	9.94	1.94	1.74	1.81	67.08	49.06	55.69	29.80	20.01	25.56	7.00	-	
Mix,	3	31.36	18.17	24.45	16.70	9.81	13.53	2.48	1.35	1.86	52.30	47.75	51.27	27.44	26.82	27.06	6.28	-	
Green oats,	5	28.82	15.51	20.03	20.47	7.05	13.85	3.32	2.02	2.68	50.69	40.81	45.90	33.12	25.20	29.70	7.87	1:9.97	
Timothy (*Phleum pratense* L.),	2	35.00	34.26	34.63	8.83	8.20	8.52	2.07	1.95	2.01	51.33	51.23	51.27	33.23	32.50	32.87	5.33	1:10.96	
Hungarian grass (*Setaria Italica* Beauv.),	1	-	-	25.93	-	-	9.38	-	-	1.01	-	-	57.80	-	-	24.66	7.15	1:6.86	
Vetch and oats (1 part vetch and 9 parts oats),	2	24.04	13.89	18.97	10.76	10.59	10.68	2.74	2.29	2.52	43.75	40.10	41.91	35.81	34.20	35.01	9.88	1:6.85	
Horse bean, whole plant (*Vicia faba* L.),	1	-	-	15.17	-	-	16.68	-	-	2.31	-	-	47.09	-	-	28.17	5.75	1:2.71	
Soja bean, whole plant (*Soja hispida* Mönch.),	9	36.36	18.54	23.12	22.19	14.02	16.76	8.98	2.71	4.99	47.89	40.80	44.44	31.89	21.67	25.92	7.89	1:4.09	
Cow-pea vines,	3	21.19	18.15	19.63	17.93	11.24	14.59	2.99	1.81	2.48	60.62	46.13	52.42	25.88	21.87	23.59	6.92	1:5.82	

Serradella (*Ornithopus sativus* Brot.),	2	19.42	15.40	17.41	17.75	12.17	14.96	2.65	2.09	2.37	41.54	35.45	38.49	38.76	26.21	32.49	11.69	1:4.67
White lupine (*Lupinus albus* L.),	1	–	–	14.65	–	–	18.71	–	–	2.41	–	–	42.67	–	–	31.18	5.03	–
Spanish moss (*Tillandsia usneoides* L.),	1	–	–	39.20	–	–	4.45	–	–	2.54	–	–	57.73	–	–	32.61	2.67	–
II. Hay and Dry Coarse Fodders.																		
English hay (mixed hays),	6	91.94	86.96	89.73	11.93	8.75	9.94	2.77	2.09	2.54	54.43	47.11	49.12	35.55	29.21	31.96	6.44	1:11.33
Rowen of mixed hay,	4	91.16	80.29	86.10	14.70	11.63	13.45	5.03	2.60	3.91	53.52	41.92	45.48	31.50	25.11	28.88	8.28	1:6.36
Timothy hay,	4	92.76	89.45	91.43	9.02	7.24	8.32	2.65	1.95	2.20	54.43	50.01	51.73	36.59	29.21	32.90	4.85	1:11.44
Red-top hay (*Agrostis vulgaris* With.),	4	93.19	91.76	92.30	8.40	6.41	7.88	1.69	1.50	1.60	54.74	50.32	52.63	34.11	31.12	32.92	4.97	1:12.06
Kentucky blue-grass (*Poa pratensis* L.),	2	96.10	93.22	94.66	8.78	8.65	8.72	2.08	2.03	2.06	49.61	44.11	46.29	36.84	32.21	34.58	8.35	1:10.38
Orchard grass (*Dactylis glomerata* L.),	4	91.62	90.86	91.17	11.29	7.57	8.99	3.56	2.40	2.91	47.34	43.50	46.15	35.79	34.12	34.89	7.05	1:10.47
Meadow fescue (*Festuca pratensis* Huds.),	5	94.70	87.84	91.09	7.85	5.89	6.76	2.17	1.65	1.87	49.18	42.03	46.31	39.90	34.61	36.93	8.13	1:13.69
Perennial rye grass (*Lolium perenne* L.),	4	93.64	90.50	92.60	16.56	6.59	11.71	3.15	1.59	2.37	55.77	38.82	48.14	30.86	26.79	29.64	8.14	1:7.40
Italian rye grass (*Lolium Italicum* A Br.),	4	92.62	90.70	91.54	9.75	6.20	8.15	2.97	1.39	1.85	52.80	43.09	49.14	36.90	31.27	33.34	7.52	1:10.90
Hungarian grass,	1	–	–	92.55	–	–	9.45	–	–	2.22	–	–	50.64	–	–	31.96	5.73	1:6.22
Barn-yard grass (*Panicum crus-galli* L.),	1	–	–	93.35	–	–	15.27	–	–	1.95	–	–	30.24	–	–	33.72	10.02	1:2.94
Low meadow hay,	1	–	–	91.99	–	–	9.51	–	–	1.88	–	–	46.27	–	–	35.59	6.75	–
Millet,	5	93.85	91.90	93.00	8.11	7.09	7.59	2.67	.89	1.74	55.80	49.62	51.64	35.91	29.80	33.54	5.49	1:7.78
Oats in blossom,	1	–	–	93.57	–	–	6.58	–	–	2.92	–	–	50.03	–	–	34.06	6.41	1:14.23
Oats in milk,	1	–	–	90.45	–	–	10.89	–	–	2.69	–	–	46.02	–	–	34.32	6.08	1:7.90
Oats, ripe,	1	–	–	91.30	–	–	6.05	–	–	2.61	–	–	48.92	–	–	36.31	6.11	1:15.03
Winter rye in blossom,	1	–	–	91.45	–	–	10.66	–	–	2.57	–	–	47.40	–	–	32.97	6.40	1:8.28

A. *Analyses of Fodder Articles* — Continued.

NAME.	Analyses.	Dry Matter.			One Hundred Parts of Dry Matter contain —												Ash.	Nutritive Ratio (Average).
					Protein.			Fat.			Nitrogen — free extract.			Fibre.				
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.		
II. Hay and Coarse Dry Fodders — Concluded.																		
Barley in milk,	1	–	–	89.75	–	–	10.26	–	–	2.76	–	–	52.91	–	–	29.12	4.95	1:9.59
Japanese buckwheat,	1	–	–	94.29	–	–	10.80	–	–	2.22	–	–	38.60	–	–	36.02	12.36	–
Dry fodder corn,	4	93.35	90.58	92.11	9.31	6.17	7.74	2.76	1.11	1.84	58.89	53.86	55.97	33.75	23.03	29.31	5.14	–
Corn stover,	25	94.44	75.00	88.50	12.15	5.46	7.35	2.63	1.08	1.33	63.05	44.65	50.83	38.83	20.93	34.85	5.64	1:11.49
Teosinte (*Euchlæna luxurians* Dur. and Asch.),	1	–	–	93.94	–	–	9.71	–	–	1.28	–	–	53.18	–	–	28.88	6.95	–
Mammoth red clover (*Trifolium medium* L.),	3	92.66	82.47	88.59	18.50	14.06	15.75	2.25	1.86	2.13	48.98	46.51	44.77	33.72	20.16	27.51	9.84	1:5.10
Medium red clover (*Trifolium pratense* L.),	2	94.90	93.98	94.44	15.01	14.63	14.82	2.62	2.36	2.49	43.88	42.81	43.34	30.76	29.97	30.37	8.98	1:5.52
Alsike clover (*Trifolium hybridum* L.),	6	93.92	86.48	90.07	17.55	14.77	16.63	3.26	1.88	2.58	46.64	38.03	42.72	32.34	21.44	26.17	11.90	1:3.25
Lucerne (alfalfa) (*Medicago sativa* Desr.),	5	95.40	84.00	91.40	16.34	11.12	14.22	2.50	1.04	1.65	51.62	40.25	46.20	34.39	25.42	29.72	8.11	1:4.09
Sand lucerne, in bloom (*Medicago media* Pers.),	1	–	–	91.20	–	–	16.26	–	–	2.59	–	–	50.31	–	–	21.27	9.57	1:3.50
Bokhara clover (*Melilotus alba* Desr.),	2	93.64	91.50	92.57	14.93	11.81	13.37	4.79	1.85	3.32	51.36	38.83	45.08	33.05	28.08	30.57	7.66	–
Blue melilot (*Melilotus cærulea* Desr.),	1	–	–	91.78	–	–	13.81	–	–	1.67	–	–	43.22	–	–	27.17	14.87	–
Sainfoin (*Onobrychis sativa*),	1	–	–	87.83	–	–	17.70	–	–	4.49	–	–	42.27	–	–	26.95	8.54	–
Sulla (*Hedysarum coronarium*),	2	91.68	89.59	90.61	17.03	16.90	16.97	3.16	2.39	2.78	58.66	41.89	50.26	28.95	12.38	20.67	9.32	–
Hairy lotus (*Lotus villosus* Thuill.),	2	89.32	87.64	88.48	16.12	13.49	14.81	3.00	2.69	2.85	57.82	50.80	54.29	24.48	15.07	19.78	8.27	–
Soja bean,	3	93.88	79.91	89.10	19.06	15.10	16.68	8.33	5.62	6.77	51.28	41.09	46.96	25.84	20.76	22.79	6.90	1:4.23

Cow-pea,	3	90.70	90.25	90.43	17.17	16.95	17.05	4.49	3.81	4.06	51.41	46.06	47.93	23.58	19.06	21.67	9.29	1:4.82
Small pea (*Lathyrus sativus*),	1	–	–	94.20	–	–	16.57	–	–	1.49	–	–	42.76	–	–	32.88	6.30	–
Serradella,	3	92.80	87.23	90.44	17.97	15.26	17.03	2.91	2.37	2.55	50.23	44.49	48.18	25.92	24.37	25.15	7.09	1:4.85
Hairy vetch (*Vicia villosa* Roth.),	1	–	–	92.56	–	–	19.58	–	–	1.22	–	–	38.95	–	–	31.88	8.37	–
Common vetch (*Vicia sativa* L.),	2	91.65	90.55	91.10	15.76	14.42	15.09	2.69	2.30	2.50	44.34	43.29	43.80	30.68	30.05	30.37	8.24	1:3.87
Scotch tares,	1	–	–	84.20	–	–	22.00	–	–	1.89	–	–	31.46	–	–	30.89	13.76	–
Vetch and oats,	2	94.22	87.47	90.85	7.72	7.70	7.71	3.37	2.53	2.95	49.95	49.00	49.47	36.22	31.73	33.98	5.89	1:11.49
Horse-bean straw,	1	–	–	90.85	–	–	9.69	–	–	1.51	–	–	37.77	–	–	41.44	9.59	1:8.55
Soja-bean straw,	1	–	–	87.00	–	–	5.39	–	–	1.80	–	–	43.72	–	–	43.85	5.24	–
White daisy (*Chrysanthemum Leucanthemum* L.),	1	–	–	90.35	–	–	7.68	–	–	2.32	–	–	46.86	–	–	36.09	7.05	–
Dry carrot tops,	1	–	–	90.24	–	–	20.12	–	–	2.01	–	–	50.39	–	–	13.61	13.87	–
Wheat straw,	1	–	–	93.80	–	–	7.20	–	–	1.63	–	–	50.46	–	–	35.91	4.80	1:8.00
Barley straw,	1	–	–	88.56	–	–	9.24	–	–	3.38	–	–	48.23	–	–	33.85	5.30	–
III. Roots, Bulbs, Tubers, etc.																		
Beets, red,	7	14.51	9.75	12.17	15.40	7.82	12.29	1.76	.59	.94	79.33	66.87	72.19	7.56	4.29	6.00	8.58	1:8.24
Beets, sugar,	11	19.53	9.87	14.73	17.44	7.32	10.97	.83	.58	.66	81.50	61.93	75.93	9.69	4.82	6.49	5.95	1:11.80
Beets, yellow fodder,	1	–	–	9.40	–	–	12.73	–	–	1.80	–	–	67.50	–	–	7.83	10.09	1:8.33
Mangolds,	3	13.08	11.73	12.25	12.84	7.83	10.37	1.01	.73	.88	73.38	70.32	71.75	9.54	7.08	7.94	9.06	1:9.94
Ruta-bagas,	3	12.77	8.25	10.88	11.46	10.34	11.01	2.32	1.23	1.53	68.58	62.27	65.88	13.12	11.03	11.83	9.75	1:11.83
Turnips,	3	12.80	8.22	9.79	10.81	9.67	10.12	2.05	1.42	1.74	70.62	65.91	68.44	12.61	10.12	11.23	8.47	1:13.26
Carrots,	4	12.52	9.95	10.72	9.63	7.98	8.93	3.94	1.67	2.34	73.96	67.24	71.27	10.76	7.55	9.19	8.27	1:9.67

A. *Analyses of Fodder Articles* — Concluded.

NAME.	Analyses.	Dry Matter.			One Hundred Parts of Dry Matter contain —												Ash.	Nutritive Ratio (Average).
					Protein.			Fat.			Nitrogen — free extract.			Fibre.				
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.		
III. Roots, Bulbs, Tubers, etc. — Concluded.																		
Parsnips,	1	–	–	19.66	–	–	6.88	–	–	3.37	–	–	74.65	–	–	7.67	7.43	–
Potatoes,	10	21.95	13.91	18.78	13.56	6.24	10.01	.83	.17	.48	87.56	78.80	81.50	3.55	1.91	2.75	5.26	1:12.25
Apples,	2	24.83	19.68	22.26	4.57	3.92	4.25	2.81	1.71	2.26	86.21	83.44	84.81	7.05	6.14	6.60	2.08	1:26.44
IV. Grains and Other Seeds.																		
Corn kernels,	28	91.98	65.50	89.55	15.02	8.49	12.24	9.43	4.25	5.47	83.98	71.06	78.44	3.38	1.03	2.14	1.71	1:8.16
Corn kernels and cobs (corn and cob meal),	36	94.00	83.91	89.71	15.06	7.82	10.00	5.27	3.36	4.09	81.41	70.13	76.73	10.41	5.63	7.56	1.62	–
Wheat grain,	1	–	–	89.42	–	–	13.35	–	–	1.79	–	–	80.26	–	–	2.42	2.18	1:6.42
Broom-corn seed,	1	–	–	85.90	–	–	11.21	–	–	4.05	–	–	74.05	–	–	8.34	2.35	–
Soja beans,	3	94.15	80.73	85.83	35.98	32.58	33.97	21.89	18.42	20.19	34.88	32.87	33.98	7.57	5.15	6.02	5.84	1:2.61
Horse beans,	1	–	–	89.72	–	–	30.03	–	–	1.11	–	–	56.48	–	–	8.11	4.27	1:2.24
V. Flour and Meal.																		
Corn meal,	25	89.95	82.96	86.03	16.08	9.73	10.87	5.08	3.10	4.48	83.24	73.20	80.80	3.60	1.20	2.18	1.67	1:9.75
Hominy meal,	3	91.89	89.30	90.75	11.88	11.20	11.61	12.22	4.89	9.33	78.07	68.00	72.55	4.78	3.69	4.08	2.43	1:8.82
Ground barley,	2	87.81	86.39	87.10	11.17	10.42	10.80	2.19	1.69	1.94	78.25	77.45	77.79	7.37	6.85	7.11	2.36	1:9.72

Broom-corn meal,	1	–	–	86.46	–	–	11.14	–	–	4.13	–	–	74.30	–	–	8.00	2.43	–
Pea meal,	1	–	–	91.15	–	–	20.95	–	–	1.67	–	–	55.02	–	–	19.42	2.94	–
VI. By-products and Refuse.																		
Linseed cake, old process,	7	92.52	88.50	90.54	39.97	30.98	36.64	9.87	6.24	7.16	44.72	37.76	40.61	9.69	8.04	8.68	6.91	1:1.66
Linseed cake, new process,	5	94.94	88.17	92.05	41.02	35.03	39.18	4.08	2.17	3.12	46.49	40.83	41.87	10.31	8.93	9.38	6.45	1:1.32
Cotton-seed meal,	9	93.16	88.81	91.31	47.04	36.54	43.12	14.72	9.57	12.89	33.87	24.64	27.50	10.83	6.28	8.29	8.20	1:1.39
Wheat bran,	27	92.58	86.30	89.43	20.54	15.67	17.85	6.08	2.80	5.03	62.18	54.27	59.48	14.26	7.49	10.70	6.94	1:4.12
Wheat middlings,	6	90.75	87.57	89.93	19.21	15.13	16.72	6.46	3.19	5.31	74.30	58.03	61.77	11.21	1.40	9.21	6.99	1:4.21
Rye bran,	2	91.82	86.30	89.06	18.98	16.52	17.75	3.05	2.07	2.55	73.56	69.24	71.70	4.54	3.46	4.00	4.30	1:4.88
Rye middlings,	1	–	–	87.46	–	–	13.15	–	–	5.61	–	–	73.52	–	–	3.70	4.02	1:7.28
Buckwheat middlings,	1	–	–	88.49	–	–	25.49	–	–	7.53	–	–	66.36	–	–	5.18	5.44	–
Gluten meal,	19	93.50	68.32	90.48	39.28	28.24	32.17	12.05	3.92	7.08	66.26	48.26	59.07	4.74	.41	1.07	.61	1:2.57
Refuse from starch works,	1	–	–	42.96	–	–	22.41	–	–	10.17	–	–	58.98	–	–	7.54	.90	–
Spent brewer's grain,	1	–	–	93.02	–	–	20.49	–	–	1.95	–	–	55.51	–	–	15.90	6.15	1:3.06
Cocoa dust, from cocoa manufactory,	1	–	–	92.90	–	–	15.47	–	–	25.85	–	–	45.99	–	–	5.86	6.83	–
Broom-corn waste,	1	–	–	91.30	–	–	6.78	–	–	1.00	–	–	48.09	–	–	39.25	4.88	–
Cotton hulls,	2	89.83	88.55	89.10	5.36	4.90	5.13	4.27	2.36	3.31	46.75	38.59	42.67	51.40	40.24	45.82	3.07	–
Apple pomace,	2	21.78	17.22	19.50	7.73	6.94	7.34	4.37	3.17	3.78	72.93	70.20	72.56	16.58	13.15	14.86	1.46	–
Apple pomace ensilage,	1	–	–	14.67	–	–	8.22	–	–	7.36	–	–	58.03	–	–	22.18	4.21	–
Sugar beet pulp, from diffusion battery,	1	–	–	10.32	–	–	12.41	–	–	.95	–	–	61.86	–	–	23.74	1.04	–
Corn cobs,	4	–	–	90.00	4.15	3.00	3.57	.67	.38	.57	63.62	60.58	61.78	33.77	31.36	32.93	1.21	1:30.85
Palmetto root,	1	–	–	88.49	–	–	3.82	–	–	.53	–	–	69.95	–	–	21.26	4.44	–

B. *Analyses of Fodder Articles with Reference to Fertilizing Ingredients.*

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	Valuation per Ton of 2,000 Pounds.
I. Green Fodders.												
Fodder corn,	14	78.61	.407	4.84	.327	.048	.153	.091	.018	.148	.380	$2 84
Fodder corn ensilage,	1	71.60	.360	–	.330	.050	.100	.090	.020	.140	.040	1 68
Sorghum,	7	82.19	.233	–	.229	.025	.076	.075	.012	.088	.136	1 09
White kibi,	2	76.45	.489	1.22	.200	.045	.232	.148	.019	.136	.652	2 09
Mochi millet,	3	62.58	.609	2.62	.407	.120	.201	.217	.021	.188	.708	2 65
Mix,	3	75.59	.499	1.54	.363	.060	.249	.245	.021	.237	.527	2 38
Green oats,	3	83.36	.489	1.31	.381	.217	.154	.134	.018	.130	.496	2 14
Vetch and oats,	1	86.11	.236	1.72	.789	.031	.087	.030	.012	.094	.331	1 58
Horse bean,	1	74.71	.675	1.45	1.370	.090	1.370	.620	.200	.330	2.040	3 87
Cow-pea vines,	1	78.81	.274	1.47	.306	.063	.300	.099	.016	.098	.077	1 51
Serradella,	2	82.59	.411	1.82	.420	.097	.460	.067	.021	.140	.097	1 92
White lupine,	1	85.35	.440	.74	1.730	.680	3.070	.730	.170	.350	.900	3 39
Spanish moss,	1	60.80	.279	1.04	.255	.263	.089	.122	.029	.030	.191	1 20
II. Hay and Dry Coarse Fodders.												
English hay,	4	11.45	1.440	6.34	1.575	.160	.399	.240	.043	.391	.997	6 71
Rowen,	2	12.48	1.746	9.57	1.966	.168	.814	.250	.064	.464	1.920	8 16

Timothy hay,	2	7.52	1,260	4.93	1.530	.220	.710	.100	–	.460	1.170	6 14
Red-top,	4	7.71	1,150	4.59	1,020	.438	.571	.134	.036	.360	1.736	5 20
Kentucky blue-grass,	2	5.34	1,320	–	1,694	.129	.398	–	.044	.431	2.863	6 45
Orchard grass,	4	8.84	1,310	6.42	1.879	.225	.456	.297	.033	.414	2.060	6 55
Meadow fescue,	6	8.89	.992	8.08	2.096	.301	.576	.187	.028	.399	1.537	5 63
Perennial rye grass,	2	9.13	1,227	6.79	1,553	.307	.642	.337	.044	.559	2.262	6 16
Italian rye grass,	4	8.71	1,189	–	1,273	.451	.857	.321	.071	.556	2.598	5 79
Salt hay,	1	5.36	1,180	–	.718	.017	.371	.335	.028	.248	–	4 92
Japanese millet ("white head"),	1	12.07	1,365	–	.788	–	.323	.328	.013	.418	1.228	5 81
Japanese buckwheat,	1	5.72	1,629	–	3.320	.349	3.418	.421	.148	.852	.378	9 38
Fodder corn,	7	7.85	1,763	4.91	.889	.175	.605	.500	.075	.542	1.270	7 40
Corn stover,	16	9.12	1,043	3.74	1,400	.112	.622	.384	.068	.293	1.885	5 28
Teosinte,	1	6.06	1,460	6.53	3.696	.109	1.597	.458	.021	.546	.315	8 72
Mammoth red clover,	3	11.41	2,231	8.72	1,223	.389	3.141	.613	.111	.546	.779	9 38
Medium red clover,	2	7.91	2,184	8.36	2,286	.210	1.689	.402	.099	.447	.919	9 91
Alsike clover,	6	9.94	2,342	11.11	2,227	.309	2.153	.537	.197	.668	1.776	10 65
Lucerne (alfalfa),	4	6.26	2,075	6.82	1,461	.814	2.211	.406	.078	.526	.513	8 92
Bokhara clover,	2	7.43	1,975	7.70	1,832	.114	1.784	.347	.023	.558	.057	8 95
Blue melilot,	1	8.22	1,319	13.65	2,796	.270	1.449	.260	.349	.544	4.008	9 55
Sainfoin,	1	12.17	2,630	7.55	2,020	.540	1.160	.430	.040	.760	.470	11 57
Sulla,	2	9.39	2,460	–	2,093	.223	2.497	.350	.114	.453	.614	10 68
Lotus villosus,	2	11.52	2,095	8.23	1,807	.499	2.220	.476	.112	.594	.976	9 37

B. *Analyses of Fodder Articles with Reference to Fertilizing Ingredients* — Continued.

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	Valuation per Ton of 2,000 Pounds.
II. Hay and Dry Coarse Fodders — Concluded.												
Soja bean,	2	6.30	2.320	6.47	1.079	.148	2.760	1.178	.115	.667	.977	$9 54
Cow-pea,	1	9.00	1.635	8.40	.913	.122	2.696	.688	.046	.527	.832	6 96
Small pea,	1	5.80	2.497	-	1.990	.469	1.373	.276	.138	.592	1.081	10 89
Serradella,	2	7.39	2.697	10.60	.652	.656	2.545	.461	.066	.777	.590	10 64
Scotch tares,	1	15.80	2.964	-	3.004	.238	1.698	.354	.460	.815	4.062	13 61
Vetch and oats,	3	9.91	1.299	9.58	1.349	.420	.663	.265	.098	.560	.521	6 24
Soja bean straw,	1	13.00	.750	-	1.322	-	.436	.469	.035	.397	.218	4 15
White daisy,	1	9.65	.279	6.37	1.253	.164	1.302	.191	.032	.435	1.110	2 54
Dry carrot tops,	1	9.76	3.130	12.52	4.883	4.028	2.089	.667	.118	.612	.098	15 52
Barley straw,	1	11.44	1.310	5.30	2.086	.183	.572	.180	-	.303	2.380	6 58
III. Roots, Bulbs, Tubers, etc.												
Beets, red,	7	87.73	.243	1.13	.436	.091	.049	.033	.004	.091	.020	1 31
Beets, sugar,	4	86.95	.223	1.04	.477	.081	.057	.040	.013	.101	.048	1 28
Beets, yellow fodder,	1	90.60	.192	.95	.462	.104	.045	.030	.005	.086	.015	1 14
Mangolds,	2	87.29	.188	1.22	.383	.125	.061	.039	.005	.093	.023	1 06

Ruta-bagas,	3	89.13	.190	1.06	.489	.070	.088	.030	.004	.123	.012	1 21
Turnips,	2	89.49	.178	1.01	.385	.078	.089	.027	.009	.104	.055	1 06
Carrots,	2	89.79	.147	9.22	.506	.062	.067	.023	.009	.093	.019	1 04
Parsnips,	1	80.34	.217	–	.617	.006	.088	.045	.005	.187	.019	1 48
Potatoes,	1	79.75	.207	.99	.294	.013	.007	.020	.002	.066	.006	1 03
Apples,	2	79.91	.130	.41	.190	.030	.030	.030	.003	.010	.003	49
IV. Grains and Other Seeds.												
Corn kernels,	13	10.88	1.822	1.53	.404	.034	.032	.206	.019	.699	.020	6 37
Corn kernels and cobs (corn and sob meal),	29	8.96	1.409	–	.472	.059	.018	.176	.011	.571	.430	5 88
Soja beans,	2	18.33	5.303	4.99	1.991	.275	.419	.909	.216	1.869	.093	21 96
V. Flour and Meal.												
Corn meal,	2	13.52	2.050	1.42	.435	.064	.034	.187	.015	.707	.005	7 85
Hominy feed,	1	8.93	1.630	2.21	.490	–	.180	.280	–	.980	–	6 14
Ground barley,	1	13.43	1.550	2.06	.341	.169	.091	.173	.013	.660	.669	6 25
Wheat flour,	1	9.83	2.210	1.22	.540	–	.170	.050	–	.570	–	8 65
Pea meal,	1	8.85	3.080	2.68	.993	.618	.302	.302	.027	.820	.122	11 31
VI. By-products and Refuse.												
Linseed cake, old process,	4	8.02	5.390	6.57	1.214	.860	.664	.763	.060	1.780	.340	21 49
Linseed cake, new process,	4	7.35	5.808	5.04	1.288	.823	.663	.655	.062	1.628	.345	22 80
Cotton-seed meal,	9	8.96	6.467	6.49	1.723	.291	.587	.589	.020	2.333	.457	26 25

B. Analyses of Fodder Articles with Reference to Fertilizing Ingredients — Concluded.

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	Valuation per Ton of 2,000 Pounds.
VI. By-products and Refuse — Concluded.												
Wheat bran,	5	11.39	2.879	6.44	1.625	.159	.168	.899	.019	2.845	.141	$14 58
Wheat middlings,	1	9.18	2.630	2.30	.630	.110	.200	.210	–	.950	–	10 63
Rye middlings,	1	12.54	1.840	3.52	.810	.030	.090	.320	.020	1.260	.170	8 46
Gluten meal,	4	8.53	5.430	.65	.045	.018	.050	.035	.069	.425	–	19 01
Spent brewer's grain,	1	6.98	3.050	6.15	1.550	.347	.296	.286	.159	1.260	1.770	12 14
Cocoa dust,	1	7.10	2.299	6.35	.630	–	.630	–	–	1.340	–	11 22
Broom-corn waste (stalks),	1	10.37	.870	4.70	1.858	–	.242	.170	–	.460	1.000	5 09
Cotton hulls,	3	10.63	.750	2.61	1.090	–	.200	.260	–	.180	.060	3 74
Apple pomace,	2	80.50	.227	.271	.134	.026	.037	.028	.008	.018	.009	90
Corn cobs,	8	12.09	.504	.815	.598	.071	.025	.045	.009	.063	.190	2 44
Palmetto root,	1	11.51	.540	.393	1.380	.345	.045	.004	.017	.157	.410	3 20

C. *Analyses of Fruits.*

NAME.	Date.	Dry Matter.	Specific Gravity of Juice.	Temperature C. of Juice (Degrees).	Total Sugar in Juice.	Glucose in Juice.	Cane Sugar in Juice.	*Soda Sol. required to neutralize 100 parts Juice.
	1877.	Per ct.			Per ct.	Per ct.	Per ct.	C. C.
Apple (Baldwin),	Sept. 1,	20.14	1.055	12—15	3.09	–	–	–
Apple (Baldwin),	Oct. 9,	19.66	1.065	12—15	6.25	–	–	–
Apple (Baldwin),	Nov. 27,	–	1.075	12—15	10.42	–	–	–
Rhode Island Greening,	Sept. 1,	20.27	1.055	12—15	3.16	–	–	–
Rhode Island Greening,	Oct. 9,	19.68	1.066	12—15	7.14	–	–	–
Rhode Island Greening,†	Nov. 27,	20.25	1.080	12—15	11.36	–	–	–
Pear (Bartlett),	Aug. 31,	15.00	1.060	12—15	4.77	–	–	–
Pear (Bartlett),	Sept. 7,	16.55	1.060	12—15	5.68	–	–	–
Pear (Bartlett),	Sept. 20,	–	1.065	12—15	8.62	–	–	–
Pear (Bartlett),‡	Sept. 22,	–	1.060	12—15	8.93	–	–	–
Cranberries,	–	10.71	1.025	15	1.35	–	–	–§
Cranberries,	1878.	10.11	1.025	15	1.70	–	–	–‖
Early York Peach (ripe),	–	–	1.045	25	–	1.92	6.09	45
Early York Peach (nearly ripe),	–	10.96¶	1.039	25	–	1.36	4.12	42.3
Crawford Peach (nearly ripe),	–	–	1.050	18	–	2.19	7.02	85.6
Crawford Peach (mellow),	–	11.36¶	1.055	18	–	1.70	8.94	76
Crawford Peach (not mellow),	–	11.88¶	1.045	22	–	1.67	5.92	64

* One part Na_2CO_3 in 100 parts of water.
† Picked October 9.
‡ Picked September 7.
§ Free acid, 2.25 per cent.
‖ Free acid, 2.43 per cent.
¶ In pulp, kept ten days before testing.

C. *Analyses of Fruits* — Continued.

[Wild and cultivated grapes.]

NAME.	Date.	Specific Gravity.	Temperature C. (Degrees).	Dry Matter.	Glucose in Juice.	Sugar in Dry Matter.	*Soda Sol. required to neutralize 100 parts Juice.
	1876.			Per ct.	Per ct.	Per ct.	C.C.
Concord,	July 17,	1.0175	31	8.30	.645	7.77	-
Concord,	July 20,	1.0150	31	8.10	.625	7.72	216
Concord,	Aug. 2,	1.0200	25	9.94	.938	9.44	249
Concord,	Aug. 16,	1.0250	28	10.88	2.000	18.38	229
Concord,	Aug. 30,	1.0500	25	15.58	8.620	55.33	120
Concord,	Sept. 13,	1.0670	23	17.48	13.890	79.46	55
Concord,	Sept. 4,	1.0700	18	19.82	16.130	81.38	49.2
Purple Wild Grape,	July 19,	1.020	31	9.00	.714	7.93	204
Purple Wild Grape,	Aug. 4,	1.020	28	12.25	1.100	8.98	246
Purple Wild Grape,	Aug. 16,	1.025	28	12.48	2.000	16.03	233
Purple Wild Grape,	Aug. 30,	1.050	26	16.58	6.500	39.81	147.6
White Wild Grape,	Aug. 31,	1.050	26	16.48	9.260	56.18	98
Hartford Prolific,	Sept. 5,	1.060	22	17.39	13.89	79.87	88.8
Ives' Seedling,	Sept. 6,	1.070	26	20.15	15.15	75.14	88.6
Iona,	Sept. 7,	1.080	21	24.56	15.15	61.68	144
Iona (mildewed),	Sept. 7,	1.045	26	15.41	6.25	40.56	204.4
Agawam,	Sept. 11,	1.075	20	20.79	17.24	82.92	94.8
Wilder,	Sept. 11,	1.064	20	16.53	13.67	82.69	56
Delaware,	Sept. 12,	1.080	24	23.47	17.86	76.09	74
Charter Oak,	Sept. 12,	1.080	24	15.98	8.77	54.94	168.3
Israella,	Sept. 16,	1.075	23	19.67	9.20	46.77	89.8
Bent's Seedling,	Sept. 20,	1.080	21	20.65	16.13	78.11	181.8
Adirondack,	Sept. 20,	1.065	21	15.11	13.17	87.16	68
Catawba,	Oct. 16,	1.080	13	23.45	17.39	74.16	82
	1877.						
Wilder,	Sept. 11,	1.065	23	16.41	15.15	92.32	60
Charter Oak,	Sept. 12,	1.055	23	16.22	9.80	60.42	96
Concord,	Sept. 13,	1.065	24	15.90	13.16	82.76	102
Concord,	Sept. 26,	1.075	24	19.34	15.43	79.78	70.8
Eumalan,	Sept. 24,	1.065	16	19.62	13.16	67.07	73
Wild White Grape,	Sept. 5,	1.050	22	15.57	7.20	46.24	140.8
Wild White Grape (shrivelled),	Sept. 20,	1.060	16	20.02	10.00	49.95	130
Wild Purple Grape (shrivelled),	Sept. 20,	1.045	16	16.69	8.22	49.25	104

* One part of pure Na_2CO_3 in 100 parts water.

C. *Analyses of Fruits* — Continued.

[Effect of girdling on grapes.]

NAME AND CONDITION.	Date.	Specific Gravity.	Temperature C. (Degrees).	Dry Matter at 100° C.	Glucose in Juice.	Sugar in Dry Matter.	*Soda Sol. required to neutralize 100 parts Juice.
	1877.			Per ct.	Per ct.	Per ct.	C. C.
Hartford Prolific, not girdled,	Sept. 3,	1.045	19	12.85	8.77	68.25	111.4
Hartford Prolific, girdled,	Sept. 3,	1.065	19	17.18	12.50	72.76	100
Wilder, not girdled,	Sept. 3,	1.055	19	15.41	10.42	67.62	108.2
Wilder, girdled,	Sept. 3,	1.075	19	17.24	14.70	85.26	88.4
Delaware, not girdled,	Sept. 4,	1.065	19	15.75	11.76	74.66	101.2
Delaware, girdled,	Sept. 4,	1.075	19	19.14	15.15	79.16	94.4
Agawam, not girdled,	Sept. 4,	1.060	19	16.60	11.37	68.48	128.2
Agawam, girdled,	Sept. 4,	1.075	19	18.45	16.31	87.42	114.8
Iona, not girdled,	Sept. 6,	1.0625	22	16.60	13.51	68.31	131.4
Iona, girdled,	Sept. 6,	1.085	22	21.48	15.63	72.76	125.6
Concord, not girdled,	Sept. 6,	1.045	22	13.46	7.46	55.42	182.4
Concord, girdled,	Sept. 6,	1.070	22	17.53	13.88	79.18	102.8
Concord, not girdled,	Sept. 26,	1.065	22	17.63	13.70	78.27	86
Concord, girdled,	Sept. 26,	1.080	22	24.47	19.61	80.13	76.8
Concord, not girdled,	Oct. 5,	1.075	12	20.92	17.50	85.37	42
Concord, girdled,	Oct. 5,	1.085	12	–	17.86	–	54

	Date.	100 Parts of Grapes contained—			
		Ash.	Moisture.	Glucose.	Tartaric Acid.
	1889.				
Concord, not girdled,	Sept. 23,	–	84.69	6.24	.75
Concord, girdled,	Sept. 23,	.42	83.00	8.13	.85
Concord, not girdled,	Oct. 8,	.53	84.51	6.09	.48
Concord, girdled,	Oct. 8,	.37	82.69	8.50	.50
	1890.				
Concord, not girdled,	Sept. 25,	.47	86.49	7.36	1.15
Concord, girdled,	Sept. 25,	.48	84.93	9.29	1.17
Concord, not girdled,	Oct. 9,	.53	85.39	7.67	.71
Concord, not girdled,	Oct. 9,	.59	85.11	6.65	.51
Concord, girdled,	Oct. 9,	.54	85.15	9.12	.74

* One part of pure $Na_2 CO_3$ in 100 parts water.

C. *Analyses of Fruits* — Continued.

[Effect of fertilization upon the organic constituents of wild grapes.]

NAME.	Date.	Dry Matter.	Specific Gravity.	Temperature C. (Degrees).	Per Cent. of Glucose.	Per Cent. of Acids.	Remarks.
	1877.						
Wild Purple Grape Berries, .	Sept. 20,	16.31	–	–	8.03	–	Unfertilized.
Wild Purple Grape Berries, .	"	19.55	–	–	13.51	–	Fertilized.
Wild Purple Grape Juice, . .	"	–	1.045	16	8.22	9.840	Unfertilized.
Wild Purple Grape Juice, . .	"	–	1.065	16	13.51	1.149	Fertilized.
Wild White Grape Berries, . .	"	20.02	–	–	–	–	Unfertilized.
Wild White Grape Berries, . .	"	21.65	–	–	–	–	Fertilized.
Wild White Grape Juice, . .	"	–	1.060	16	10.00	1.846	Unfertilized.
Wild White Grape Juice, . .	"	–	–	–	14.29	.923	Fertilized.

[Effect of fertilization upon the ash constituents of grapes.]

NAME.	Date.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	Remarks.
	1876.								
Wild Purple Grapes,	Sept. 13,	50.93	.15	22.23	5.59	.79	17.40	2.93	Unfertilized.
Wild Purple Grapes,	Sept. 20,	62 65	.85	14.24	3.92	.53	13.18	4.63	Fertilized.
Concord Grapes, .	July 7,	41 73	5.04	25.03	7.80	.55	18.48	1.37	Unfertilized.
Concord Grapes, .	July 17,	47.34	1.13	24.21	–	.75	21.38	.43	Unfertilized.
Concord Grapes, .	Aug. 18,	51.14	3.19	16.20	6.38	.65	20.77	1.67	Unfertilized.
Concord Grapes, .	Sept. 13,	57.15	4.17	11.30	3.10	.40	12.47	11.82	Unfertilized.
	1878.								
Concord Grapes, .	Oct. 3,	64.65	1.42	9.13	3.63	.50	14.87	5.80	Fertilized.

C. *Analyses of Fruits* — Concluded.

[Ash analyses of fruits and garden crops.]

NAME.	Ash.	100 Parts of Ash contained —						
		Potash.	Soda.	Lime.	Magnesia.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.
Concord Grape (fruit),	–	51.14	3.19	16.20	6.38	.65	20.77	1.67
Unfermented juice,*	–	50.85	.48	3.69	4.25	.10	6.43	.90
Fermented juice,	–	40.69	–	6.85	6.24	–	9.04	–
Skins and pulp,	–	7.70	.42	57.36	8.80	.08	24.40	1.32
Seeds,	3.08	6.71	–	–	3.03	–	17.20	.29
Stems of grapes,	4.69	20.91	–	20.20	8.45	–	17.75	2.09
Young branches,*	–	24.71	.94	40.53	10.66	1.08	17.16	4.92
Wood of vine,†	2.97	22.57	–	9.72	4.28	–	14.07	23.84
Clinton Grape (fruit),	–	58.45	3.51	13.34	7.37	.90	18.19	–
Baldwin Apple,	–	63.54	1.71	7.28	5.52	1.08	20.87	3.68
Strawberry (fruit),‡	.52	49.24	3.23	13.47	8.12	1.74	18.50	5.66
Strawberry (fruit),§	–	58.47	–	14.64	6.12	3.37	17.40	–
Strawberry vines,	3.34	10.62	13.35	36.63	3.83	6.91	14.48	14.17
Cranberry (fruit),	.18	47 96	6.58	18.58	6.78	–	14.27	–
Cranberry vines,	2.45	12.98	3.27	16.49	10.33	3.35	10.94	34.04
Currants, red,	.47	47.68	4.02	18.96	6.23	1.20	21.91	–
Currants, white,	.59	52.79	3.00	17.08	5.68	2.67	18.78	–
Crawford Peach, sound,	–	74.46	–	2.64	6.29	.58	16.02	–
Crawford Peach, diseased,‖	–	71.30	–	4.68	5.49	.46	18.07	–
Branch, sound,	–	26.01	–	54.52	7.58	.52	11.37	–
Branch, diseased,‖	–	15.67	–	64.23	10.28	1.45	8.37	–
Asparagus stems,	–	42.94	3.58	27.18	12.77	1.22	12.31	.08
Asparagus roots,	–	56.43	5.42	15.48	7.57	–	15.09	3.67
Onions,	–	38.51	1.90	8.20	3.65	.58	15.80	3.33

* With tendrils and blossoms. † One year old. ‡ Wilder. § Downing. ‖ Yellows.

D. Analyses of Sugar-producing Plants.

[Composition of sugar beets raised upon the college grounds during the season of 1870 and 1871.]

NAME.	Date.	Brix Saccharometer (Degrees).	Per Cent. of Sugar.	Non-saccharine Substances.
Electoral,	Sept. 10,	14	12.30	1.75
Imperial,	" 12,	15	12.59	2.41
Vilmorin,	" 13,	14.5	12.95	1.55
Imperial,	" 18,	14	10.79	3.21
Imperial,	Oct. 11,	15	12.05	2.95
Electoral,	" 16,	15	12.22	2.78
Vilmorin,	" 18,	16	13.13	2.87
Imperial,	Nov. 14,	15	11.60	3.34
Vilmorin,	" 21,	15.5	13.12	2.38
Vienna Globe,*	Sept. 19,	11	8.00	3.00
Common Mangold,*	" 19,	9	5.00	3.97

* Fodder beets.

[Percentage of sugar in different varieties of sugar beets grown on college farm during the season of 1882.]

NAME.	Source of Seed.	Weight in Pounds.	Per Cent. of Sugar in Juice.
I. Vilmorin,	Saxony,	$\frac{3}{4}$ to $\frac{7}{8}$	15.50
II. Vilmorin,	Saxony,	$\frac{3}{4}$ to 1	15.61
I. White Imperial,	Saxony,	$\frac{3}{4}$ to $1\frac{3}{4}$	14.20
II. White Imperial,	Saxony,	$1\frac{3}{4}$ to 2	10.27
New Imperial,	Saxony,	$1\frac{1}{4}$ to $1\frac{3}{4}$	13.80
I. White Magdeburg,	Saxony,	$1\frac{1}{2}$ to 2	13.10
II. White Magdeburg,	Silesia,	$1\frac{1}{2}$ to $1\frac{3}{4}$	10.06
Quedlinburg,	Saxony,	$1\frac{1}{2}$ to $1\frac{3}{4}$	13.44
White Silesian,	Silesia,	$1\frac{1}{4}$ to $1\frac{1}{2}$	9.72

D. Analyses of Sugar-producing Plants — Continued.

[Effect of soil and fertilization on Electoral sugar beets.*]

SOIL.	MANURE.	Specific Gravity Brix (Degrees).	Per Cent. of Sugar in Juice.	Non-saccharine Substances.	Cane Sugar in Soluble Matter.
Sandy loam, .	Fresh yard-manure, . .	16.5	12.50	4.00	75.08
Clayish loam, .	Fresh yard-manure, .	15.5	11.05	4.45	71.30
Warm alluvial, .	Yard-manure and chemicals, . . .	12.75	9.17	3.58	71.92
Warm alluvial, .	Fresh hog-manure, .	13.5	9.53	3.97	70.06
Light, sandy soil,	No manure, . . .	18.5	13.73	4.77	74.21
Alluvial soil, .	Brighton fish, . . .	14.5	11.15	3.35	76.90
Heavy soil, .	Yard-manure, . .	12.25	8.15	4.10	66.53
–	–	13.5	9.90	3.60	73.33

* Not raised on college farm (Connecticut valley).

[Effect of fertilization on sugar beets.*]

FERTILIZERS.	Percentages of Sugar in Juice.		
	Freeport.	Electoral.	Vilmorin.
Fresh horse-manure, ...	11.96	9.42	7.80
Blood guano without potash, . .	10.99	10.10	10.20
Blood guano with potash, . . .	12.55	13.24	10.50
Kainite and superphosphate, . .	13.15	12.16	10.50
Sulphate of potash, ...	14.52	14.32	12.78
Second year after stable-manure, .	13.49	12.78	12.19

* All were grown on the same soil, — sandy loam (college)

D. Analyses of Sugar-producing Plants — Continued.

[Effect of different modes of cultivation on Electoral sugar beets.]

Locality of Beet-field.	Date.	Brix Saccharometer (Degrees).	Per Cent. of Cane Sugar.	Non-saccharine Substances.
1. Sing Sing, N. Y.,	1872–73	11	7.80	3.20
2. Washington, N. Y.,	"	14	10.97	3.03
3. South Hartford, N. Y.,	"	15	11.70	3.30
4. Greenwich, N. Y.,	"	12	9.50	2.50
5. Frankfort, N. Y.,	"	13.5	11.00	2.50
6. Albion, N. Y.,*	"	18	15.10	2.90
Albion, N. Y.,†	"	14	9.70	4.30

* From beets weighing from 1½ to 2 pounds. † From beets weighing from 10 to 14 pounds.

1. Soil, loam resting on clayish hard-pan, had been for several years in grass. Tomatoes had been the preceding crop. Five hundred pounds of a phosphatic blood guano were applied before planting.

2. Soil, a clayish loam, had been ploughed seven inches deep. A liberal amount of rotten sheep-manure was placed in trenches and covered by running two furrows together, thus forming a ridge on which the seed were planted.

3. Soil, a gravelly loam, which had been richly manured with stable compost and twice ploughed before planting.

4. Soil, a sandy loam, underlaid by fine sand. The seed were planted on ridges, which covered trenches containing a little rotten stable-manure.

5. No details of modes of cultivation received.

6. Soil, a dark, reddish-brown, rich, deep, sandy loam. Clover had been raised for two years previous to a crop of carrots, which preceded the sugar beets. The beets were the second crop after the application of twenty loads of stable-manure per acre.

Composition of Canada-grown Sugar Beets.

[1872 and 1873.]

Where Grown.	Weight of Roots.	Specific Gravity of Juice (Brix).	Temperature of Juice.	Per Cent. of Cane Sugar in Juice.
Echaullon de Montreal,	2 to 2½ lbs.	15.4°	64° F.	11.38
Riviere du Loup,	2 to 3¼ lbs.	14.5°	63° F.	10.20
Chambly,	2 to 2½ lbs.	13.2°	63° F.	9.02
Maskinonge,	2 to 3 lbs.	13.4°	63° F.	8.83

D. Analyses of Sugar-producing Plants — Continued.

[Early Amber Cane.]

Date.	CONDITION OF CANE.	Brix Saccharometer (Degrees).	Temperature C. (Degrees).	Glucose.	Cane Sugar.	Soda Solution required to neutralize 100 parts of Juice.	Solids.
1879.				Per ct.	Per ct.	C. C.	Per ct.
Aug. 15, .	No flower stalks in sight,* . .	4.2	27	2.48	None	6.8	7.93
Aug. 16, .	No flower stalks in sight,* . .	5.8	24	4.06	None	9.0	11.10
Aug. 20, .	Flower stalks developed,* . .	7.9	24	3.47	2.15	7.0	13.00
Aug. 24, .	Flowers open,*	8.7	23	3.70	3.00	4.0	14.07
Aug. 27, .	Plants in full bloom,* . . .	10.0	25	3.65	4.13	10.0	15.48
Aug. 30, .	Seed forming,*	9.5	30	4.00	3.81	9.5	16.14
Sept. 2, .	Seed in milk,*	10.7	27	3.85	4.41	9.5	15.85
Sept. 9, .	Seeds still soft,*	12.1	22	3.21	6.86	9.5	26.13
Sept. 9, .	Stripped on Sept. 2,*	12 8	22	3.77	6.81	9.5	26.75
Sept. 18, .	Left on field without stripping,* .	13.2	22	3.57	7.65	–	–
Sept. 18, .	Tops removed,*	13.8	22	3.16	8.49	–	–
Sept. 18, .	Tops and leaves removed on Sept. 9,*	11.5	22	3.16	5.85	–	–
Sept. 18, .	Tops removed; left on field 9 days,*	12.8	22	10.00	.60	–	–
Sept. 21, .	Juice from the above,* . . .	13.0	21	–	–	–	–
Sept. 23, .	Juice from the above,* . . .	15.0	18	–	–	–	–
Sept. 25, .	Left on field 3 weeks,† . . .	19.8	21	11.91	6.27	–	–
Sept. 28, .	Left on field 3 weeks,† . . .	17.8	12	16.60	–	–	–
Oct. 4, .	Left on field 3 weeks,† . . .	16.1	17	8.62	6.16	12.0	–
Oct. 7, .	Freshly cut. Ground with leaves,†	16.7	20	4.16	9.94	6.8	–
Oct. 8, .	Freshly cut. Stripped two weeks,†	12.8	17	5.16	5.27	7.0	–
Oct. 9, .	Freshly cut. Stripped two weeks,†	18.4	17	7.57	–	10.6	–
Oct. 14, .	Several weeks old,†	18.2	15	10.42	–	10.4	–
Oct. 18, .	Several weeks old,†	15.1	23	7.57	–	–	–
Oct. 19, .	Several weeks old,†	15.5	15	9.22	–	13.6	–
Oct. 22, .	Several weeks old,†	16.2	16	8.30	–	–	–
Oct. 23, .	Several weeks old,†	18.3	17	11.30	5.5	14.0	–
Oct. 24, .	Several weeks old,†	16.6	15	8.63	–	9.0	–

		100 Parts of Cane contained —				
		Moisture.	Glucose.	Cane Sugar.	Total Sugar.	
1889.						
October, .	Early Tennessee sorghum, mature, .	77.43	1.79	3.21	5.00	Grown on station grounds.
October, .	Price's new hybrid, ripe, . . .	77.80	2.92	3.78	6.70	
October, .	Kansas orange, green, . . .	80.67	2.38	3.63	6.01	
October, .	New orange, green, ...	78.30	2.96	3.85	6.81	
October, .	Honduras, green, ...	77.55	3.08.	4.01	7.09	

* Raised on the college farm. † Raised by farmers in the vicinity of the college.

D. Analyses of Sugar-producing Plants — Concluded.

[Composition of the juice of corn stalks and melons.]

Variety.	Specific Gravity.	Temperature C. (Degrees).	Glucose.	Cane Sugar in Juice	Solids.
			Per ct.	Per ct.	Per ct.
Northern corn,*	1.023	27	4.35	0.28	15.18
Black Mexican sweet corn,† . .	1.048	27	2.06	7.02	17.44
Evergreen sweet corn,† . . .	1.052	–	4.85	5.70	20.38
Common sweet corn,‡	1.035	–	6.60	None.	–
Common yellow musk-melon,§ .	1.040	26	1.67	2.65	–
White-flesh water-melon, . . .	1.025	18	2.91	2.16	–
Red-flesh water-melon, . . .	1.025	22	3.57	2.18	–
Red-flesh water-melon, . . .	1.025	19	3.84	1.77	–
Nutmeg musk-melon,‖ . . .	1.030	19	3.33	2.11	–
Nutmeg musk-melon,¶ . . .	1.050	20	2.27	5.38	–
Nutmeg musk-melon,** . . .	1.030	19	2.50	1.43	–

* Tassels appearing.
† Ears ready for the table.
‡ Kernels somewhat hard.
§ Fully ripe.
‖ Not ripe.
¶ Ripe.
** Over-ripe.

E. *Analyses of Dairy Products.*

	Analyses.	Solids.			Fat.			Curd.			Salt.			Ash.
		Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	
Whole milk,	50	16.70	11.96	13.60	5.45	2.48	3.95	–	–	3.20	–	–	–	.70
Skim-milk,	–	–	–	10.19	–	–	.37	–	–	3.53	–	–	–	.80
Buttermilk,	–	–	–	8.16	–	–	.21	–	–	2.79	–	–	–	.80
Cream,	59	28.51	21.30	25.26	20.90	13.74	17.47	–	–	–	–	–	–	.62
Butter,	24	92.89	87.05	89.17	89.05	81.43	83.98	.89	.51	.66	6.45	3.61	4.80	–
Whole-milk cheese (Jersey),*	1	–	–	62.84	–	–	37.32	–	–	22.13	–	–	–	3.39
Whole-milk cheese,*	1	–	–	64.17	–	–	34.34	–	–	26.69	–	–	–	3.14
Cheese from milk skimmed after twelve hours' standing,*	1	–	–	62.70	–	–	27.81	–	–	30.37	–	–	–	4.52
Cheese from milk skimmed after twenty-four hours' standing,*	1	–	–	57.76	–	–	23.42	–	–	31.99	–	–	–	2.35
Cheese from milk skimmed after thirty-six hours' standing,*	1	–	–	56.05	–	–	17.67	–	–	33.24	–	–	–	5.14
Cheese from milk skimmed after forty-eight hours' standing,*	1	–	–	54.59	–	–	15.77	–	–	34.94	–	–	–	3.88
Cheese from skim-milk, with addition of buttermilk,*	1	–	–	51.62	–	–	18.35	–	–	28.63	–	–	–	4.64
Genuine oleomargarine cheese,*	1	–	–	62.10	–	–	31.66	–	–	25.94	–	–	–	4.50

* From analyses made in 1875.

E. *Salt for Meat Packing and Dairy Purposes.*

KIND AND SOURCE.	Moisture 100° C.	Sodium Chloride.	Calcium Sulphate.	Calcium Chloride.	Magnesium Chloride.	Sodium Sulphate.	Magnesium Sulphate.	Insoluble Matter.	Remarks.
Rock salt of Pettite Anse, La.,	.330	98.882	.782	.004	.003	–	–	–	Sent on for examination.
Rock salt of Neyba, San Domingo, W. I.,	.300	98.330	1.480	–	.090	.070	.070	–	
Solar salt, Onondaga, N. Y.,	2.500	96.004	1.315	.092	.089	–	–	–	
Solar salt, Hocking Valley, O.,	2.130	97.512	None.	.234	.089	–	–	–	
Solar salt, Saginaw Valley, Mich.,	3.344	95.813	.316	.356	.140	–	–	–	
Solar salt from Kansas,	4.950	93.060	1.220	–	.240	.350	.180	–	
Solar salt, Lincoln County, Neb.,	1.200	98.130	.250	–	.080	.390	None.	–	
Common fine and boiled salt, Onondaga, N. Y.,	3.000	95.353	1.355	.155	.136	–	–	–	
Common fine and boiled salt, Portsmouth, Mich.,	6.752	90.682	.805	.974	.781	–	–	–	
Common fine and boiled salt, Mason City, O.,	3.470	95.789	–	.614	.041	–	–	–	
Dairy and table salt, Ashton's (English),	0.760	97.652	1.430	–	.060	–	.048	.050	
Onondaga dairy salt,	0.700	97.832	1.263	–	.037	.026	.023	.120	
Fine salt, Bulletin 26, I.,	3.280	95.091	1.487	.032	.075	–	–	.035	
Fine salt, Bulletin 26, II.,	4.591	94.012	1.177	.143	.049	–	–	.028	
Fine salt, Bulletin 26, III.,	4.616	94.236	.999	.071	.026	–	–	.052	Salicylic acid: trace.
Dairy salt, sent on from Amherst, Mass,	0.145	98.520	1.009	.189	.065	–	–	.072	
Ashton salt (sent on),	.760	97.650	1.430	–	.060	–	.050	.050	
Onondaga factory-filled (sent on),	.600	98.280	.910	–	–	.030	.060	.120	
Dairy salt, sent on from Amherst,	.505	98.202	.877	.168	.046	–	–	.202	
Rock salt from Retsof salt mines,	2.600	95.940	.420	.330	.010	–	–	.700	
Royal salt,	.880	97.877	1.108	.016	.010	–	–	.102	
Excelsior salt,	.320	98.009	1.644	.013	.014	–	–	.020	
Genesee salt,	.295	98.513	1.160	.010	.012	–	–	.010	
Genesee salt,	.235	98.563	1.137	.045	.020	–	–	–	
Bradley salt,	.200	98.575	1.185	.029	.007	–	–	–	
Higgin's Eureka salt,	.855	98.891	.906	.293	.055	–	–	–	
Worcester refined salt,	.565	97.935	1 376	.097	.027	–	–	–	

METEOROLOGY.

1890.

The meteorological observations have been continued as in previous years. The temperature, the force and direction of the wind, and the amount of cloudiness, are recorded each day at 7 A.M., 2 P.M. and 9 P M. During the summer months the reading of a wet-bulb thermometer is taken at these times. Instruments recording the maximum and minimum temperatures, and measuring the rainfall, are also used.

Besides our regular observations, records are made of casual meteorological phenomena, and the condition of farm crops, trees, etc., as affected by the weather or season.

Monthly and annual reports are sent to the headquarters of the signal service at Washington, D. C., and to the New England Meteorological Society.

During the summer months we have sent weekly weather crop reports to the latter society, and have furnished a partial monthly report for the use of the secretary of the State Board of Agriculture.

The weather during January and February was exceptionally mild, even more so than during 1889. Considerable difficulty was experienced in getting ice. In this vicinity none was cut until February, when it reached a thickness of from six to eight inches.

There was hardly enough snow for good sleighing at any time during the winter. A snow-storm on the 20th of February gave sleighing for two or three days, and one on the 6th of March gave fair sleighing until the 10th. The temperature for March was lower than for either of the preceding months.

The total snow fall for March is recorded as seventeen inches, but with one exception it disappeared soon after falling

The last heavy frost, during the spring, occurred April 29. Light frosts were reported on the 17th and 23d of May.

The weather during the early part of the season was, on

the whole, favorable to the growth of farm crops. The first crop of hay was large, and most of it was secured in good condition during the dry weather preceding the heavy rain beginning July 24. The crop of rowen suffered somewhat on account of that drought, and other crops suffered to some extent. During the remainder of the growing season there was sufficient rain, most of the time an abundance.

Frost held off remarkably late, the first in the autumn occurring September 25, after which there was none until October 13.

The first trace of snow occurred November 11. There were 15.5 inches during December, with good sleighing most of the time.

The rainfall during the year was slightly above the average, and fairly distributed. The rains during April, June and November, however, were light, being less than two inches in each case.

The heaviest rain of the season occurred on the 24th, 25th and 26th of July, giving a rainfall of 4.65 inches.

From the 9th to the 15th of September it rained every day, giving 2.57 inches, and on the 17th of that month there was a fall of 1.50 inches. A storm on the 23d and 24th of October gave 2.30 inches.

During the year there were one hundred and fifty days recorded as "cloudy," seventy-one as "clear." The greatest number of cloudy days, seventeen, occurred in October, and the greatest number of clear days, nine, in November and December. In August there were but three clear days.

The prevailing wind during six months of the year was north-west. It was north-east during March, April and August, south-east during May and June, and south during July.

The mean annual temperature for the year, 46.43°, was about the average. The principal variations from the monthly average temperatures occurred in January, which has had a higher temperature during the period covered by the Amherst observation only in 1838, 1870 and 1880. February also was considerably warmer than usual. The average for December is the lowest since 1876.

The highest temperature during the year was 92°, occurring July 8; the lowest, — 9.5°, occurring March 7.

Summary of Meteorological Observations, 1890.

	Temperature, Degrees Fahrenheit.											Relative Humidity, Per Ct.				Precipitation, Inches.	
	7 A. M.	2 P. M.	9 P. M.	Mean.	Maximum.	Minimum.	Range.	Absolute Maximum.	Date.	Absolute Minimum.	Date.	7 A. M.	2 P. M.	9 P. M.	Mean.	Depth of Water.	Date of Greatest Fall.
January,	26.7	35.1	30.1	30.5	39.8	21.5	18.3	61.5	2d	4.5	25th,	–	–	–	–	2.61	15th-16th
February,	26.6	36.0	30.4	30.8	39.9	22.5	17.4	59.5	26th	3.0	22d, 23d	–	–	–	–	4.01	8th
March,	25.1	35.6	30.0	30.2	38.9	21.6	17.3	59.5	12th	—9.5	7th	–	–	–	–	4.81	22d, 23d
April,	38.6	55.2	44.0	45.5	57.6	32.8	24.8	77.5	13th	22.0	19th	–	–	–	–	1.64	4th
May,	51.6	64.9	54.6	56.4	67.6	44.7	22.9	79.0	14th	32.0	2d, 12th	84.1	60.9	76.2	73.7	5.14	26th-27th
June,	60.2	73.2	62.5	64.6	76.3	53.1	23.2	86.5	30th	38.0	3d	83.7	57.4	78.4	73.2	1.48	5th-6th
July,	63.6	77.0	65.9	68.1	79.7	56.2	23.5	92.0	8th	41.0	10th, 21st	85.0	54.0	78.3	72.4	5.44	24th-26th
August,	62.5	74.3	64.3	66.3	76.6	57.2	19.4	86.0	4th, 6th	41 5	25th	89.8	61.1	83.6	78 2	4.60	19th-20th
September,	54.4	67.3	57.9	59.4	69.7	50.3	19.4	78.5	2d, 7th	29.5	25th	93.4	68.8	89.0	83.7	5.28	17th
October,	42.5	55.1	46.1	47.4	56.8	39.3	27.5	76.0	1st	26.5	22d	89.1	61 2	83.8	78.0	6.89	16th-17th
November,	32.4	43.2	34.7	36.3	46.0	27.5	18.5	60.0	6th	13.0	28th	–	–	–	–	1.24	17th
December,	18.6	25.1	21.6	21.7	36.2	5.4	30.8	42.5	23d	—5.5	30th	–	–	–	–	3.18	26th
Sums,	502.8	642.0	542.1	557.2	685.1	432.1	253.0	858.5	–	236.0	–	525.1	363 4	489.3	459.2	46.32	–
Means,	41.90	53.50	45.18	46.43	57.09	36.01	21.08	71.54	–	19.67	–	87.52	60.57	81.55	76.53	3.86	–

Miscellaneous Phenomena, — Dates.

	Frost.	Snow.	Rain.	Thunder-storms.	Lunar Halos.
January, . .	4, 19, 23,	10, 11, 23, 31,	1, 5, 6, 10, 11, 12, 13, 15, 16, 20, 27, 30.	–	–
February, . .	7, 14,	2, 7, 10, 20,	4, 7, 8, 14, 17, 18, 24, 25, 28.	–	1.
March, . .	24,	3, 5, 6, 15, 19, 28, 29, 31,	1, 11, 14, 21, 22, 23, 25, 26, 28.	28,	45, 24.
April, . . .	2, 3, 6, 8, 12, 16, 20, 21, 29.	–	4, 7, 8, 9, 25, 26, 27,	–	29.
May, . . .	17, 23,	–	1, 3, 4, 5, 6, 10, 11, 14, 15, 16, 17, 20, 26, 27, 28.	14, 28,	–
June, . . .	–	–	3, 4, 5, 6, 12, 13, 14, 15, 19.	5, 6,	–
July, . . .	–	–	3, 4, 7, 15, 19, 24, 25, 26, 31.	7, 19, 26, 31,	–
August, . .	–	–	1, 9, 10, 12, 17, 18, 19, 20, 21, 22, 23, 26, 27, 30.	17, 19,	–
September, . .	25,	–	5, 6, 9, 10, 11, 12, 13, 14, 15, 17, 26.	17,	–
October, . .	13, 16, 22, 23,	–	4, 6, 7, 8, 10, 14, 16, 17, 19, 20, 23, 24, 25, 29, 30.	–	22, 25.
November, . .	1, 3, 4, 5, 6, 13, 14, 15, 21, 24, 26, 30.	–	2, 9, 11, 15, 17,	–	–
December, . .	2,	3, 5, 6, 26, 30,	3, 17, 18, 21,	–	16, 25.

C. A. GOESSMANN,
Director.

ANNUAL REPORT OF FRANK E. PAIGE,

TREASURER OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION,

For the Year ending Dec. 31, 1890.

RECEIVED.

Cash from Dr. J. P. Lynde, balance of last year,	$15 00	
Cash from State Treasurer, appropriation,	10,000 00	
Cash from farm, etc.,	1,422 07	
Cash from fertilizer account,	1,905 00	
		$13,342 07

EXPENDED.

Cash paid salaries,	$4,478 03	
Cash paid laboratory supplies,	1,213 01	
Cash paid printing and office expenses,	838 34	
Cash paid farmer and farm labor,	2,050 10	
Cash paid farm stock and feed,	1,278 96	
Cash paid incidental expense,	899 93	
Cash paid construction and repairs,	599 22	
Cash paid expense of board of control,	75 62	
Cash paid fertilizer account,	1,565 00	
Cash on hand,	343 86	
		$13,342 07

SUMMARY OF THE PROPERTY OF THE MASSACHUSETTS STATE AGRICULTURAL EXPERIMENT STATION.

(*Dec. 31, 1890.*)

Buildings, etc.,	$30,702 00	
Farm inventory (live stock, crops, etc.),	2,299 45	
Office furniture (chemical laboratory),	1,456 75	
Chemicals and chemical apparatus (chemical laboratory),	2,605 95	
Furniture, herbariums and library (agricultural and physiological laboratory),	903 25	
Instruments, apparatus, etc. (agricultural and physiological laboratory),	822 10	
Total of inventory,		$38,789 50

BOSTON, MASS., Jan. 8, 1891.

This is to certify that I have examined the books and accounts of Frank E. Paige, Treasurer of the Massachusetts Agricultural Experiment Station, for the fiscal year ending Dec. 31, 1890, and find them correct, and all disbursements properly vouched for, with a balance of cash in treasury of three hundred forty-three dollars and eighty-six cents, which is shown to be in bank.

W. R. SESSIONS,
Auditor.

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